DIVISION OF CONSTRUCTION
TRANSPORTATION LABORATORY

DESIGN AND DEVELOPMENT OF AN IMPROVED MODEL MOBILE AIR QUALITY MONITORING VAN FOR HIGHWAY ENVIRONMENTAL IMPACT STUDIES

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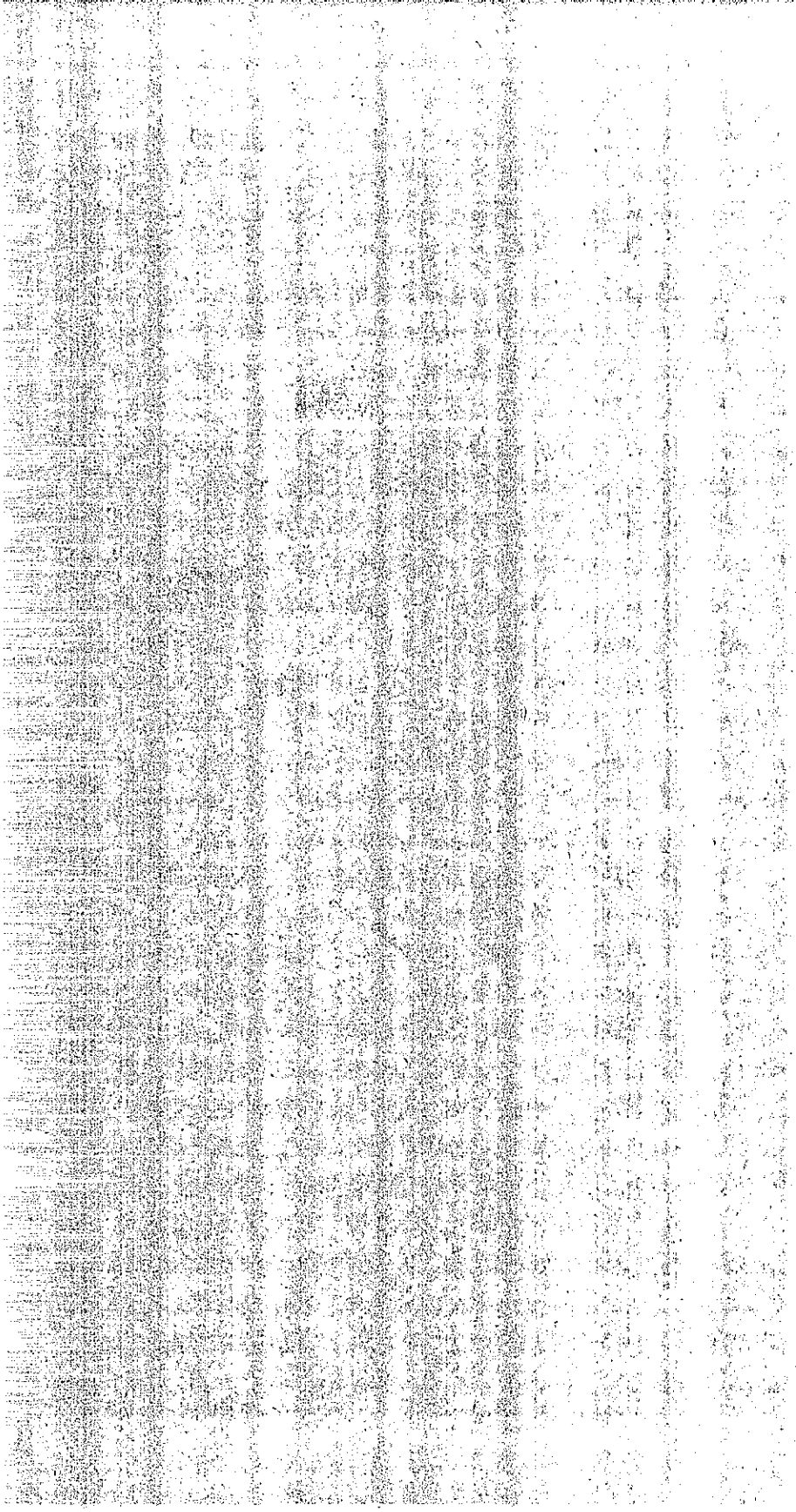

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16 ABSTRACT

Field data on ambient air pollutant levels are required for quantitative air quality studies. To provide these data Caltrans developed and built several mobile air monitoring vans equipped to measure ambient levels of carbon monoxide, hydrocarbons, oxides of nitrogen, and ozone. In addition, meteorological data including wind speed and wind direction can be obtained. Provision of gases and equipment for calibration of analyzers and access for maintenance were major considerations in the design of the van interior. This report is a description, including drawings, of a second generation air monitoring van for assessing ambient levels of air pollutants.

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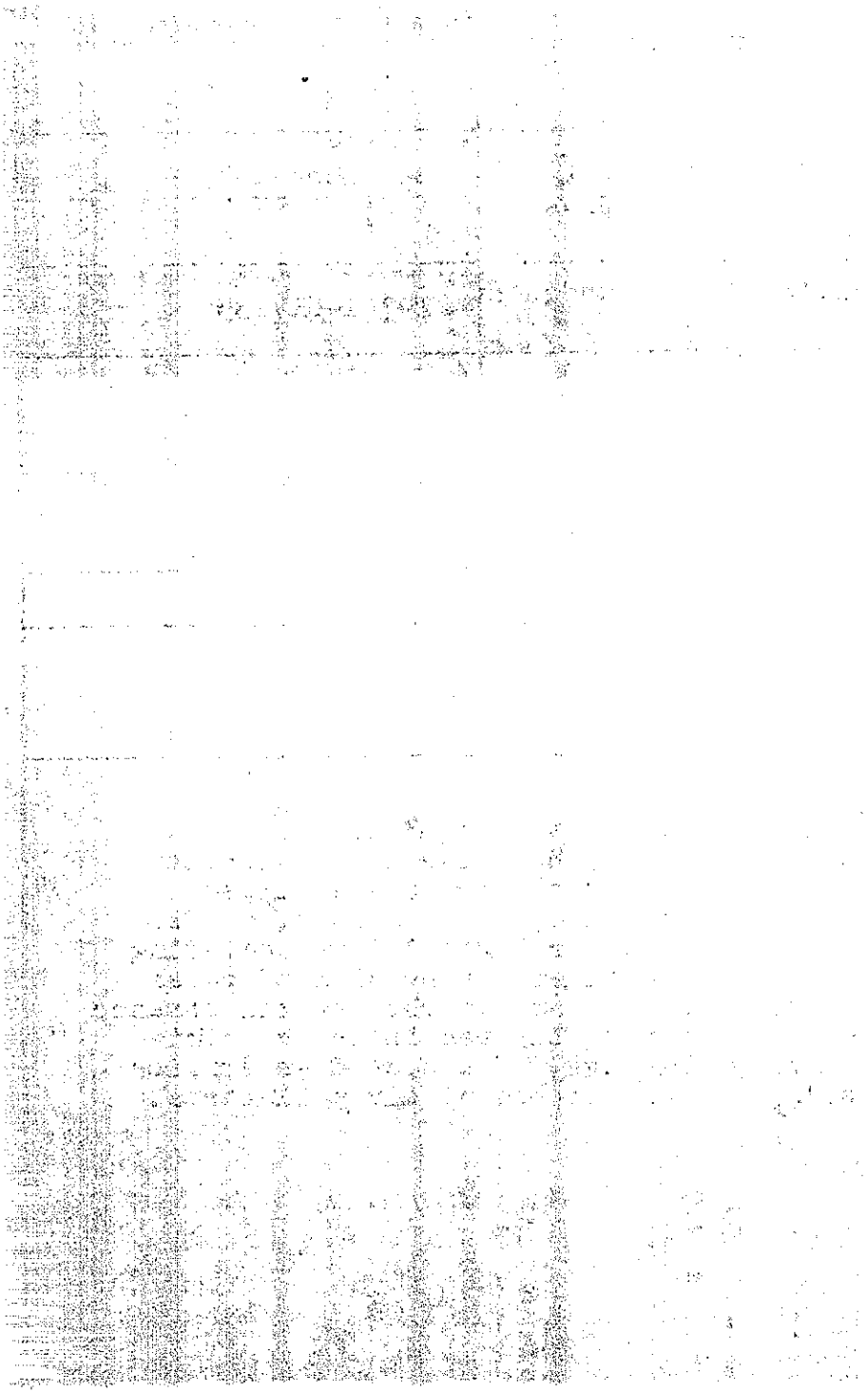

STATE OF CALIFORNIA
DEPARTMENT OF TRANSPORTATION
DIVISION OF CONSTRUCTION
OFFICE OF TRANSPORTATION LABORATORY

December 1977

TL No. 617138

Mr. C. E. Forbes
Chief Engineer

Dear Sir:

I have approved and now submit for your information this final equipment development project report titled:

DESIGN AND DEVELOPMENT OF AN IMPROVED MODEL MOBILE AIR QUALITY MONITORING VAN FOR HIGHWAY ENVIRONMENTAL IMPACT STUDIES

Study made by . . . . . Enviro-Chemical Branch

Under the Supervision of . . . . . E. C. Shirley, P.E.
and
C. R. Sundquist, P.E.

Principal Investigator . . . . . K. O. Pinkerman, P. E.

Co-Principal Investigator . . . . . R. W. Breazile

Report Prepared by . . . . . K. O. Pinkerman, P. E.

Very truly yours,

George A. Hill

GEORGE A. HILL
Chief, Office of Transportation Laboratory

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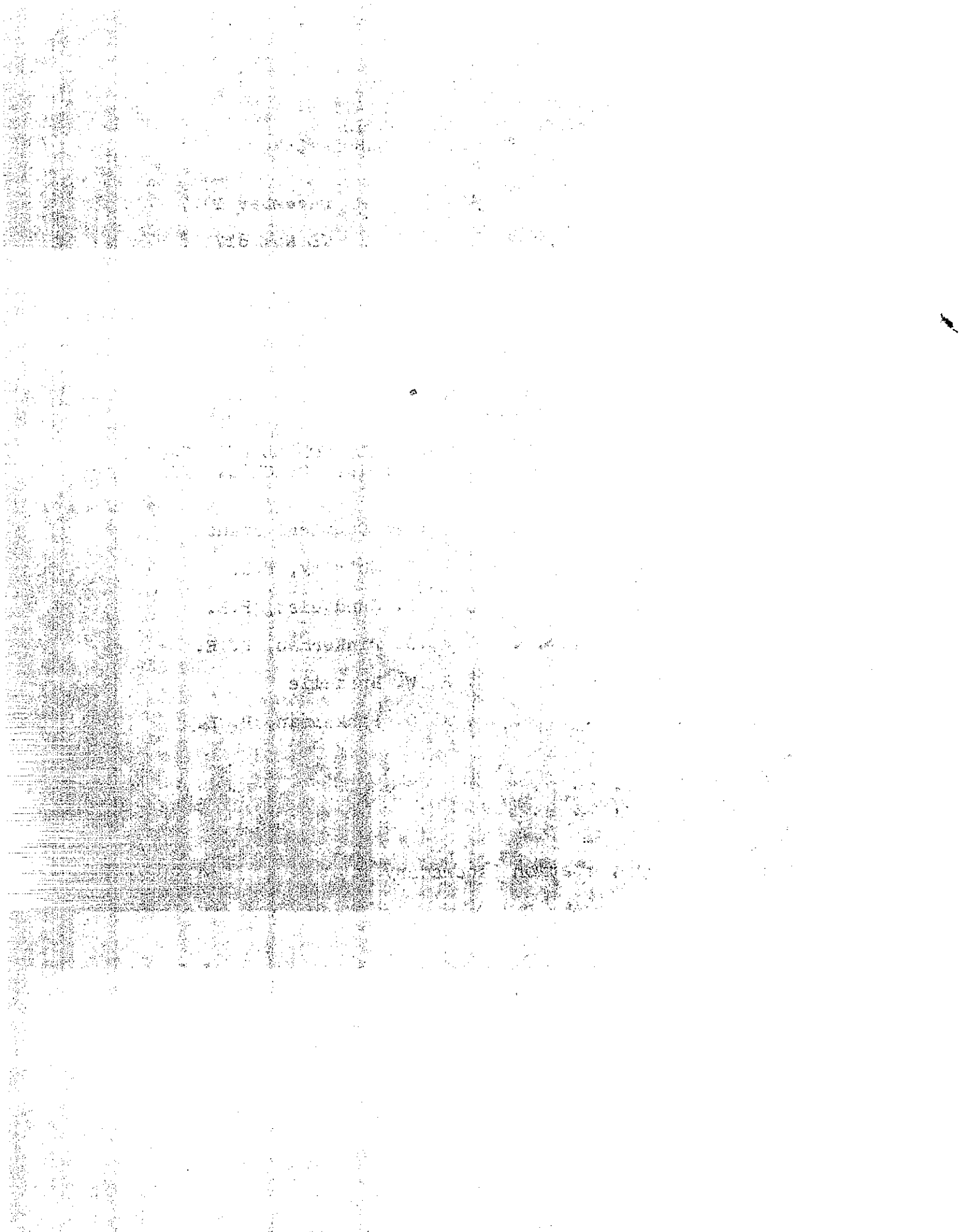
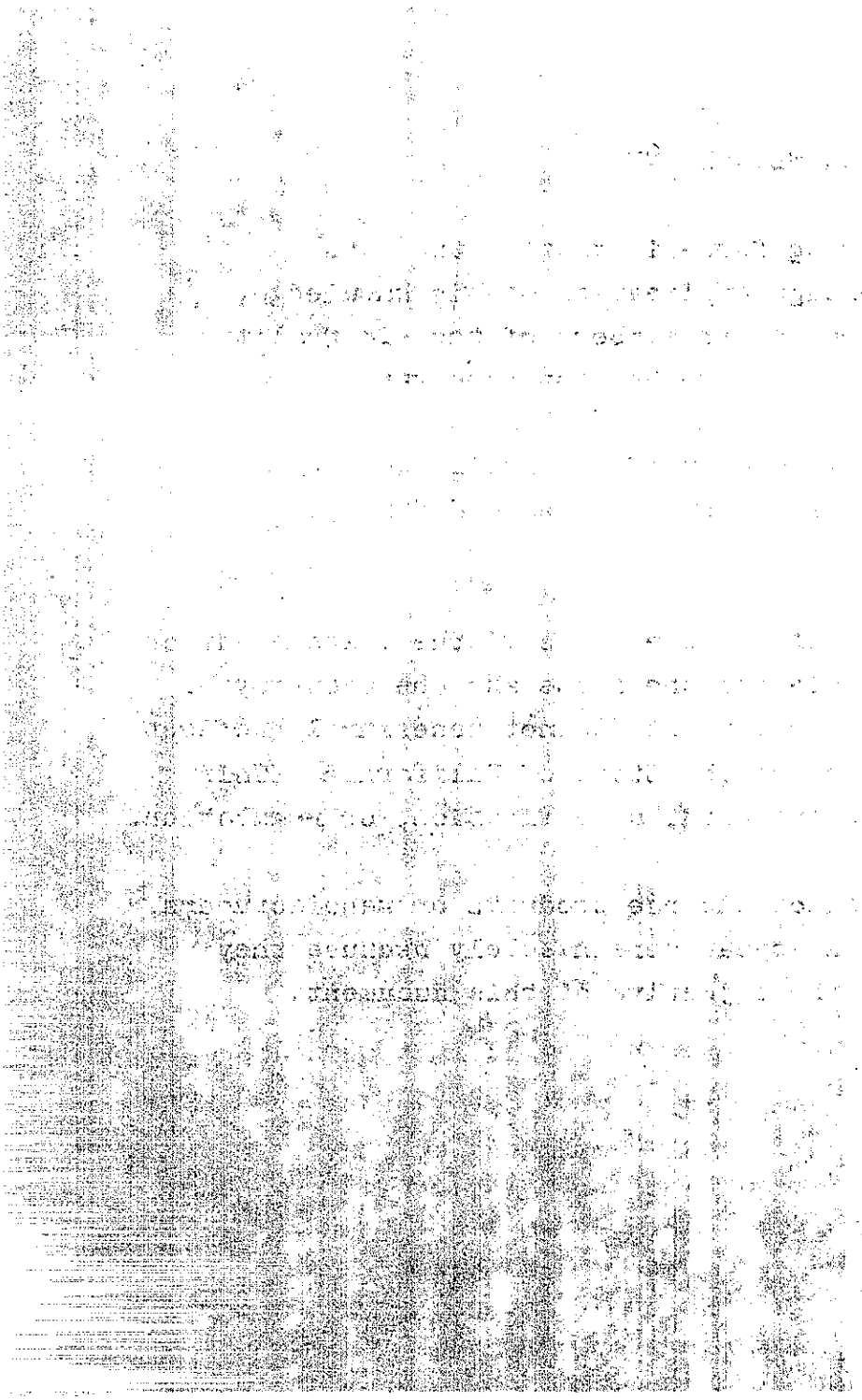


ACKNOWLEDGEMENTS

Robert Breazile was the driving force in getting the vans equipped and constructed through application of his knowledge, skills, and patience. Several other members of the Air Quality Section were instrumental in getting the prototype van constructed. Special acknowledgement is due Orvis Box and David Clark. Andrew Ranzieri, was chief of the Air Quality Section during the time the vans were designed and for most of the construction period.



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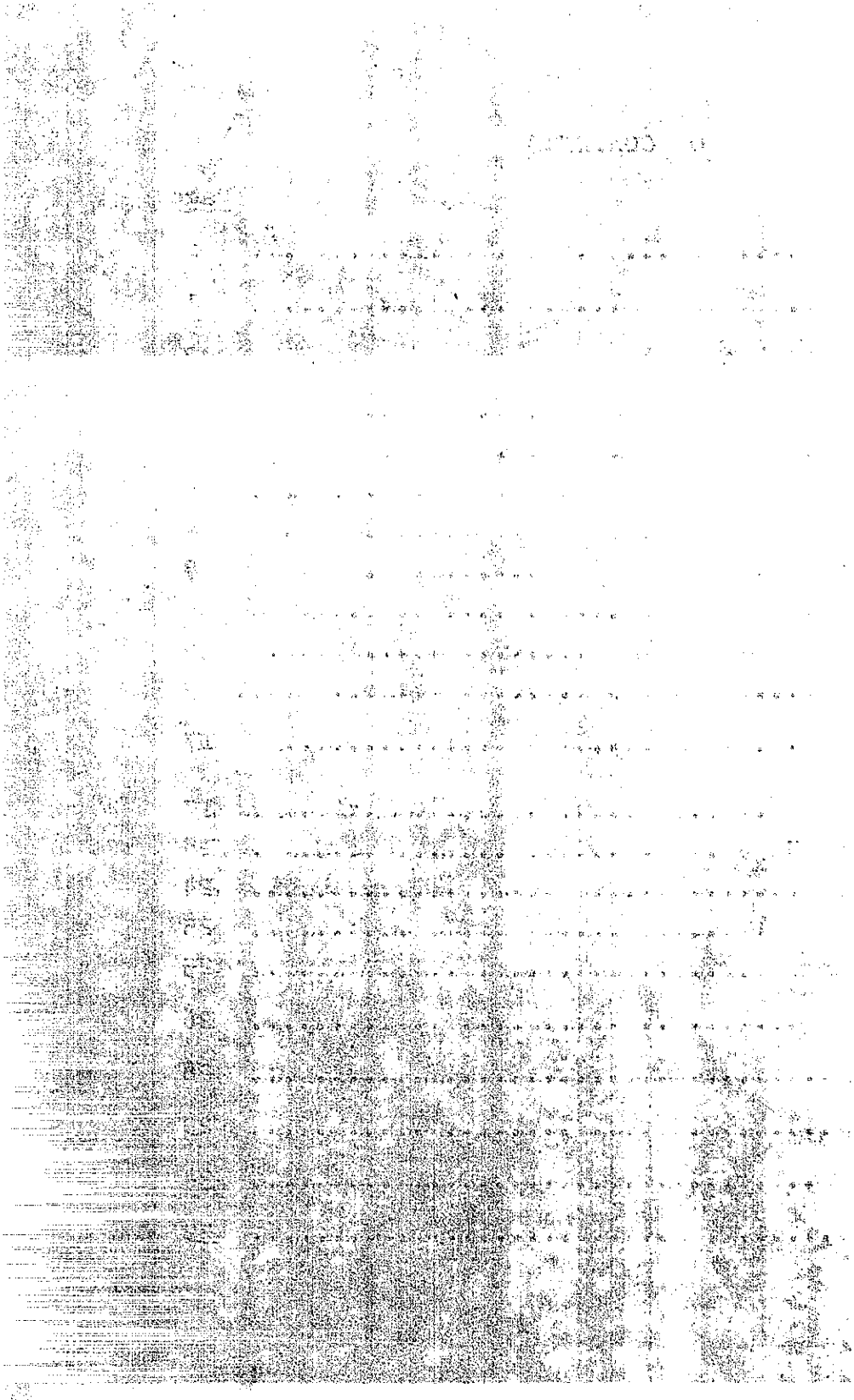


INTRODUCTION

During 1972, the California Department of Transportation placed into field use two experimental air quality monitoring vans for obtaining ambient air pollutant concentrations. The data obtained were used in Environmental Impact Statements. These units were evaluated in field usage for two years. At that time, an interim report titled "Design and Development of a Mobile Air Quality Monitoring Van for Highway Environmental Impact Studies" was published. The report documented certain necessary changes in the design to simplify operation and maintenance.

These changes were presented as: (1) the need for a larger van (2) better access to installed equipment (3) using linoleum floor covering instead of carpet (4) The use of Ground Fault Interrupt (GFI) protection on exterior power circuits (5) lower ranges (0-50 ppm) on the carbon monoxide analyzer to reflect ambient levels normally monitored and (6) use of an oilless type main vacuum pump to prevent interference with hydrocarbon analysis.

This report describes the next step in the evolution of this type of mobile air monitoring van. It covers all aspects of vehicle selection, options, and modifications which form the basis for the air monitoring package.

The monitoring system covers 5 different complex pollutant analysis systems and meteorological sensors. Due to the complexity, a detailed layout and support package is presented to assist others in the task of building a basic and easy to maintain mobile laboratory.

Some aspects considered during design and layout were operator usage, calibration requirements, means of conducting future maintenance, ease of construction, and the quality and quantity of data to be obtained.

VEHICLE DESCRIPTION

Basic Vehicle

Based on four years of field experience with a small mini-van style vehicle, it was concluded that a larger, flat walled vehicle would be very advantageous for mounting equipment, as well as for operation and servicing installed components.

The type of vehicle selected as the basis for the second generation air monitoring van was a GMC "Step Side Van" (see Figure 1). This is a King Model No. CP 31442 with a body No. E33. It has a 157 inch (399 cm) wheel base and a 10,000 lb (4540 kg) GVW rating. The engine is a 454 cubic inch (7440 cc) V-8 with a heavy duty automatic transmission and is equipped with power disc brakes.

The design of this unit gives a load space 171 inches (434 cm) long, 90 inches (229 cm) wide and 76 inches (193 cm) high with flat surfaces broken only by the wheel well intrusions.

Several manufacturers make this type unit with Union Body Company fabricating the shell on the frame. The low bid contractor in this case was GMC which supplied the unit shown.

Body

The Union Body Company Model E33 body gives the added length and head clearance required for this application. It is constructed with all aluminum components and is finished inside in flat aluminum sheet. It is insulated with 2 inches (5 cm) of fiberglass as the factory would not supply the 2 inch (5 cm) foam insulation specified.

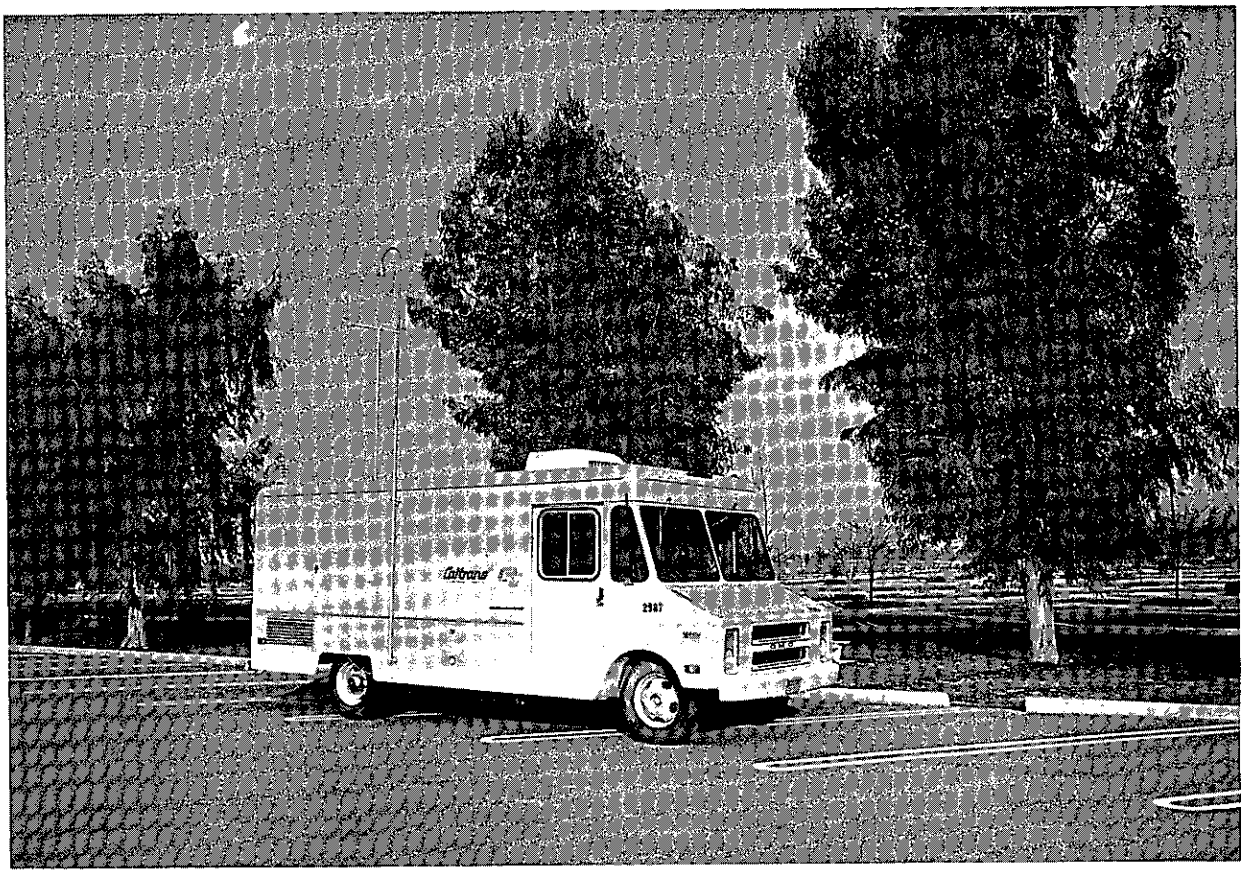


Fig. 1. Air Monitoring Van - Sample Mast View

The van as insulated was accepted as meeting specifications. This insulation turned out to be insufficient and in-service instrument problems required the addition of a second air conditioner (10,000 BTU's) and subsequently a new generator with 7500 watt capability.

The body has two sliding doors for driver and passenger and two hinged rear doors which provide equipment access.

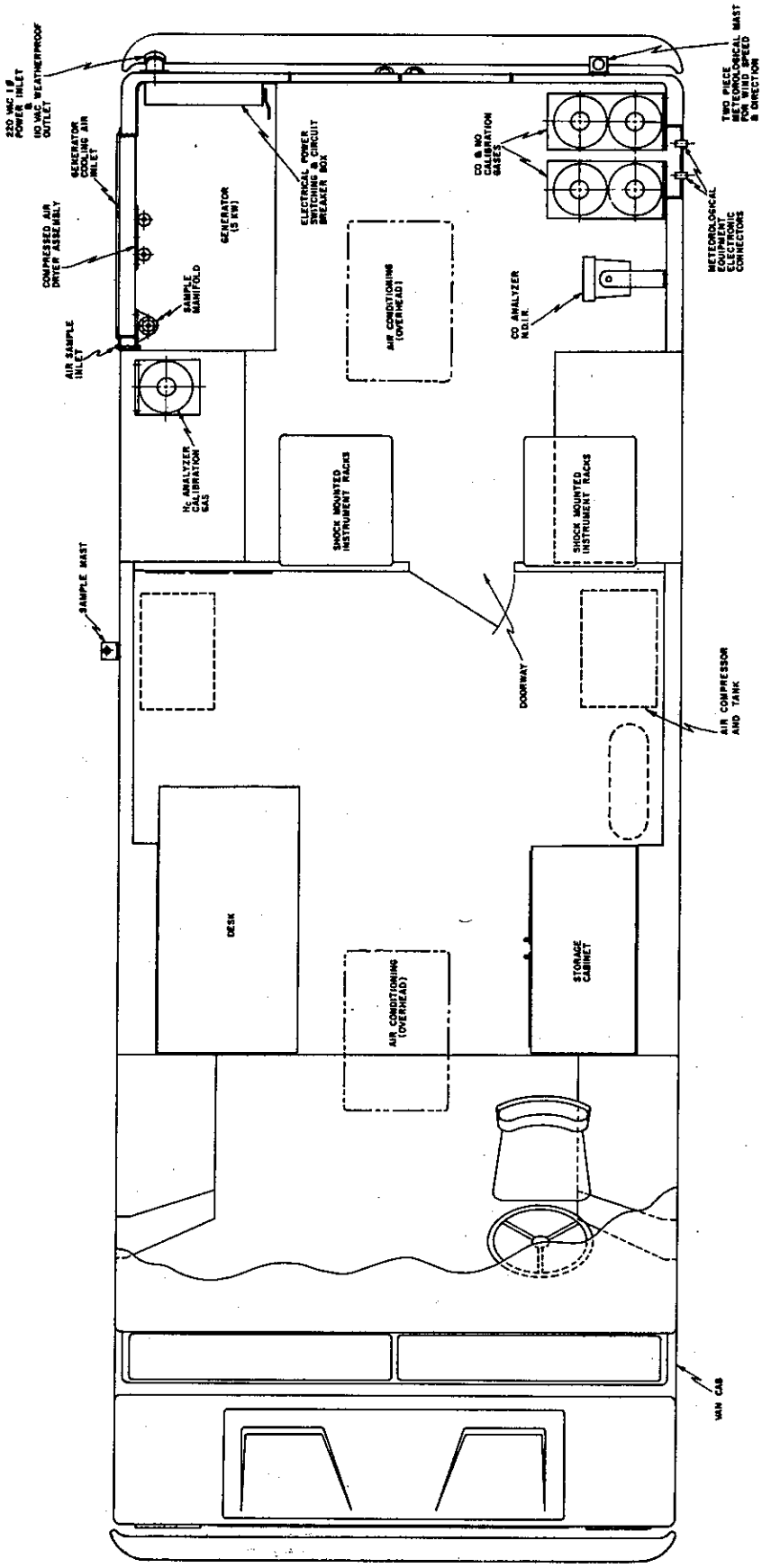
Vehicle Manufacturer Options

Some accessories were specified for this unit. Their selection is based on Caltrans experience with previous vans and included the following:

1. Power steering
2. Vacuum assisted disc brakes
3. Automatic transmission
4. 400 + cubic inch (6555 cc) V-8 engine
5. Auxiliary gas tank or a 50 gallon (189litre) main tank
6. Bucket-type foam cushioned driver seat (commercial type)
7. Tinted glass (all windows)
8. Paint (a light color with the roof painted white for reflecting sun's rays)
9. Wiring for trailer towing (including receptacle)
10. Outside rear view mirrors with convex spot mirrors for better visibility.

Vehicle Modifications

The changes and additions discussed below are modifications relating directly to the basic vehicle. Other changes are discussed under headings for the appropriate piece of equipment.



AIR MONITORING VAN
DISTRICT TYPE

5 Figure 1-A

Generator

As the van is intended to operate in remote rural locations as well as at urban sites, an on-board power supply is required. The van is equipped with a 5 Kw gasoline powered generator*. Several companies make a generator of this capacity and they are similar as to size and weight. The generator used was a Kohler 5CM61. It is a 120/240 volt single phase low speed (1800 RPM) generator.

The design of the generator, the method of mounting, and its cooling system are very critical. A motor home type generator is the only acceptable unit. It is designed for mounting in an enclosed compartment and also is mounted to isolate vibration.

The enclosed operation of the air-cooled generator requires a fresh air supply from the exterior of the van and a positive exhaust of heated air.

The engine-driven fan draws cooling air through louvered openings (approximately 170 square inches (1097 square cent.)) in the van exterior and passes it through ducts, over the fins on the engine block, then down and out the floor of the compartment to the atmosphere. Heat rejection to the van interior has been minimal.

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*Note: Due to adding second air conditioner this generator was replaced with an Onan 7.5 kw gasoline powered generator Model 7.5JB-3CR. The housing needed only slight modification to accept this unit.

The exhaust from the gasoline engine is routed through the floor of the vehicle to a muffler and then expelled at the side of the vehicle. This exhaust is then taken away from the van by means of flexible tubing. The tubing can be of several kinds but shop type exhaust tubing is recommended for the first 6 feet (1.8 metres) due to exhaust heat. Flexible plastic ducting can then be added as needed to get the exhaust outlet approximately 30-50 feet (9.1-15.2 metres) downwind. This has proven to be sufficient except for calm conditions when the exhaust tends to build up and affect the pollutant readings. Alert operators can note the background changes and document their occurrence so that the data remain accurate.

Generator Enclosure

Housing for the generator was designed to accomplish several objectives. Namely, to shield noise and heat from the work area and to provide storage and working space.

The housing is constructed from 3/4 inch (1.9 cm) thick plywood and is mounted directly to the right rear wall of the van. This positions the generator behind the vehicle wheel well and encloses it with plywood on three sides with the van exterior wall on the fourth side. The housing can be opened from the top and sides so that generator removal and service is possible. All interior openings are sealed and the interior of the enclosure is lined with 1/8 inch (0.3 cm) thick lead sheet. This lowers the noise emitted to the van interior to a 70-75 dBA level. This compares to the OSHA requirement of 85 dBA for work areas where an employee will be exposed up to 16 hours.

A power switching box to enable selection of on-board or outside power is mounted on the rear wall outside the enclosure immediately above the generator (see Figure 17). A later section of this report (Van Construction Criteria, Appendix III) explains the power wiring system and related components.

Air Conditioner

With the type of sensitive electronic equipment installed, heat becomes a critical factor in their proper operation. Some analyzers generate a substantial heat load of their own, and with the heat load on the vehicle walls on hot summer and fall days, an air conditioner becomes a necessity.

On this style of van, a roof mounted refrigeration type air conditioner is the best choice. The size to use depends primarily on climate and secondarily on van color, insulation, and heat generation from equipment mounted in the van. For this application, a 10,000 BTU Easy Start Unit was selected as a compromise between cooling capacity and power consumption. In areas of high ambient temperature where the van could use commercial power, a second similarly sized air conditioner would be recommended*. This would still leave the option of turning on just one air conditioner unit when utilizing generator power. This is an important consideration since analyzer operation becomes questionable at temperatures above 90°F (32°C) and instrument signal drift becomes excessive over 85°F (30°C).

If it were possible to obtain the vans from the manufacturer with foam (polyurethane) insulation in the roof and walls, the heat load would be greatly reduced. To date, the only insulation available is a minimal amount of fiberglass. In addition, tinted glass and/or covering the windows while on site would also reduce the heat load.

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*Note: In the vans that operate in the hot areas of California a second air conditioner has been mandatory.

Floor Covering

In the front half of the van, the operator work area, the metal floor was covered with a durable grade of linoleum for easy cleaning. The metal floor behind the dividing bulkhead was left bare as this is the service area and heavy cylinders are moved across it.

Carpet of a commercial indoor-outdoor grade is an option if finances permit. It has a benefit in sound deadening ability as well as some insulation value, but cleaning problems place it low in priority.

Van Layout

The main drawback to earlier van designs has been equipment access for adjustments and maintenance. This became the primary development criterion when the location of components was considered. It was decided that dividing the van into two distinct areas was appropriate. One would be the operation side, the other, the service or support area.

To separate the two areas, a bulkhead was designed including a pass through door way. This bulkhead is located just forward of the vehicle wheel wells and is pop-riveted to the vehicle walls and roof. Two instrument racks were installed behind the bulkhead. One is a 70 inch (178 cm) rack on the floor between the wheel wells, the other is a 60 inch (152 cm) high unit on top of the driver's side wheel well. These were shock mounted and faced through the bulkhead. This allows forward movement out of the rack for instrument removal or adjustment.

All frequently used controls such as valves for calibration gases, flow meters, switches, etc. are mounted on panels either directly on the bulkhead or in the instrument rack near the instrument to which they relate. (See figure 5.)

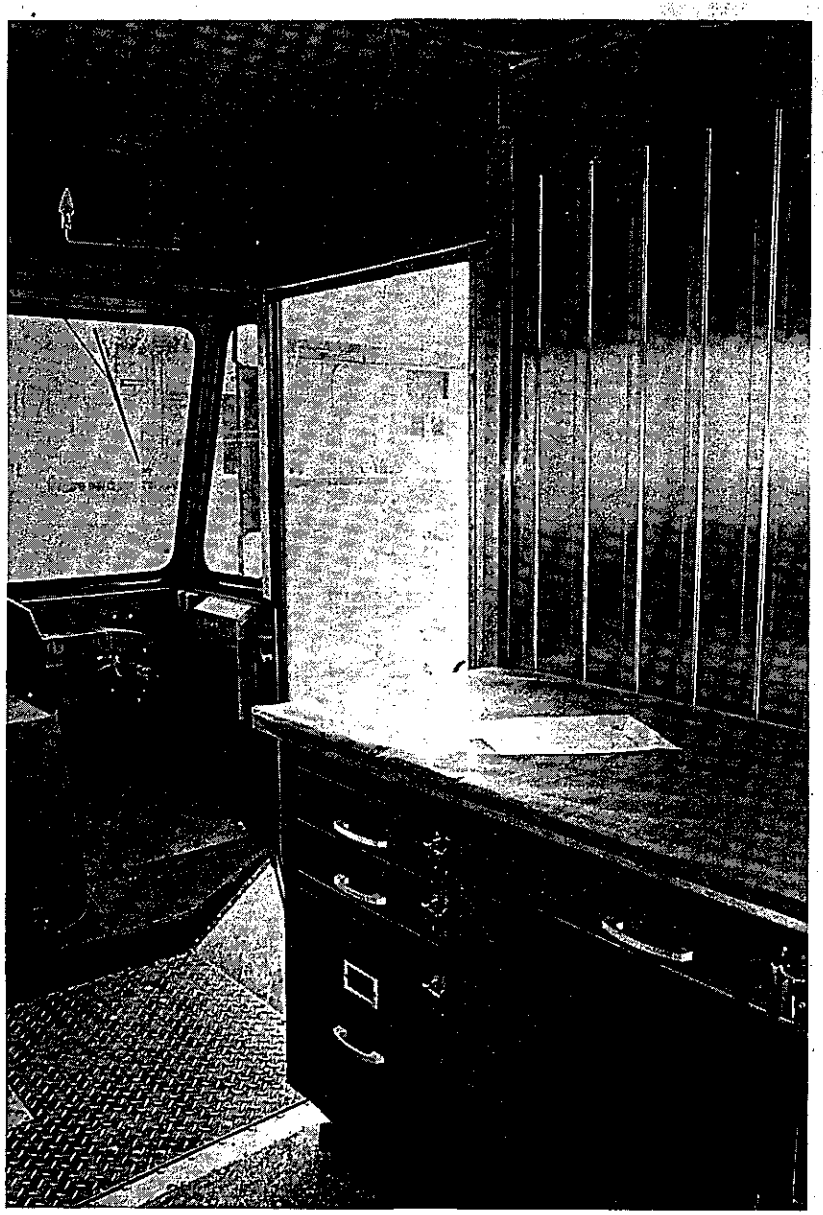

Fig. 3 Front Right-Operator's Desk

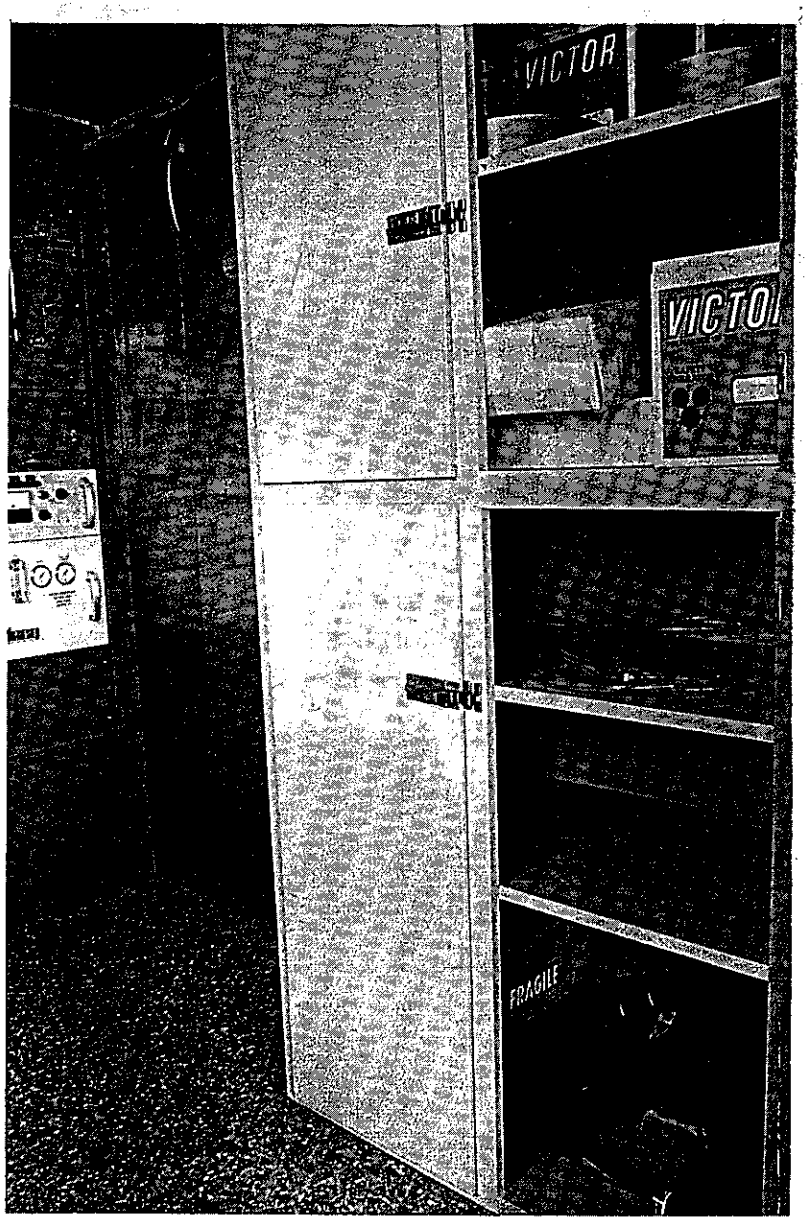

Fig. 4 Front Left - Storage Cabinet

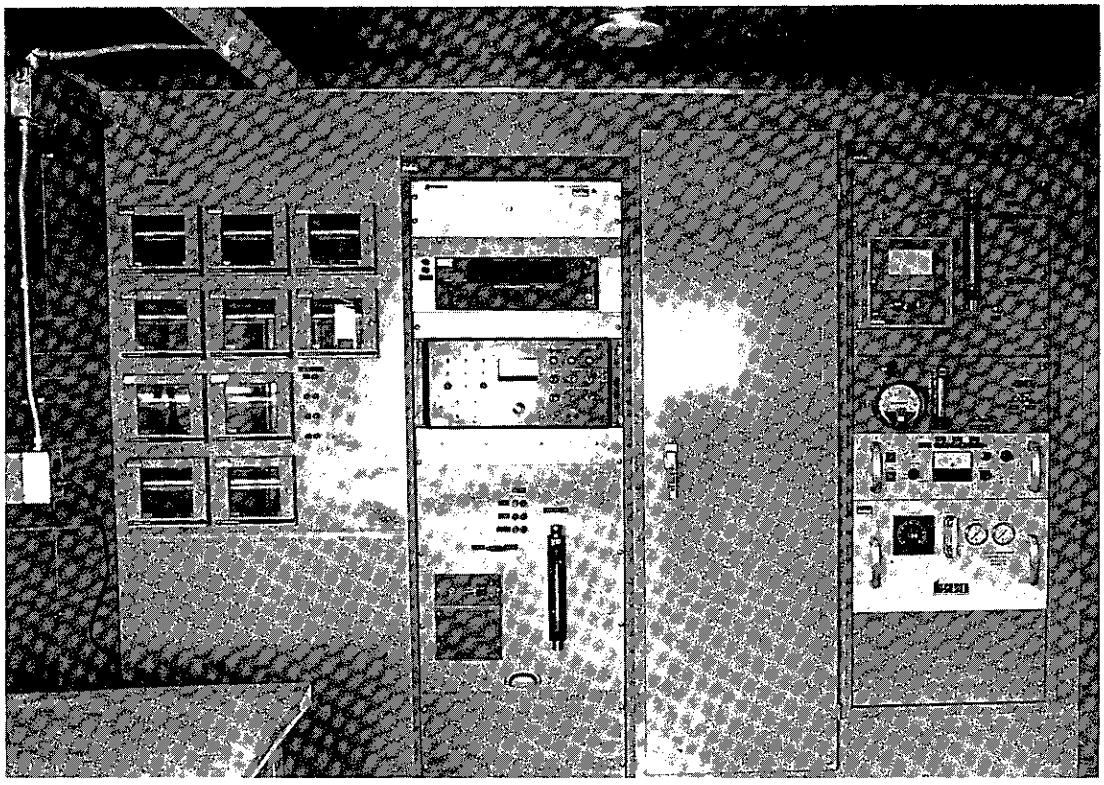

Fig. 5 Instrument Panel - Overall View

The following systems face the operator:

1. Sample flow control panel

2. Beckman Model 315 BL carbon monoxide analyzer amplifier with flow and calibration control system

3. Thermo Electron Model 14B Oxides of Nitrogen Analyzer (self contained flow system)

4. Dasibi Model 1003AH Ozone Analyzer (self contained flow system)

5. Bendix Model 8201 Reactive Hydrocarbon Analyzer

6. Support Drawer for hydrocarbon analyzer including clean air package

7. TechEcology Model 100 Meteorological Translator

8. Esterline Angus Mini Servo Recorders (one for each of ten parameters measured).

The particulars of each system are discussed in a later section.

In addition, the front section of the van contains a desk for use as a working surface, reducing data, taking notes, and storage of analyzer test methods and technical manuals.

A four door storage cabinet is also built-in behind the driver's seat. This floor to ceiling cabinet is included for storage of basic supplies and instrumentation components during moving. There is clearance between the cabinet and the ceiling to provide storage for the two sections of the sample mast and the meteorological mast.

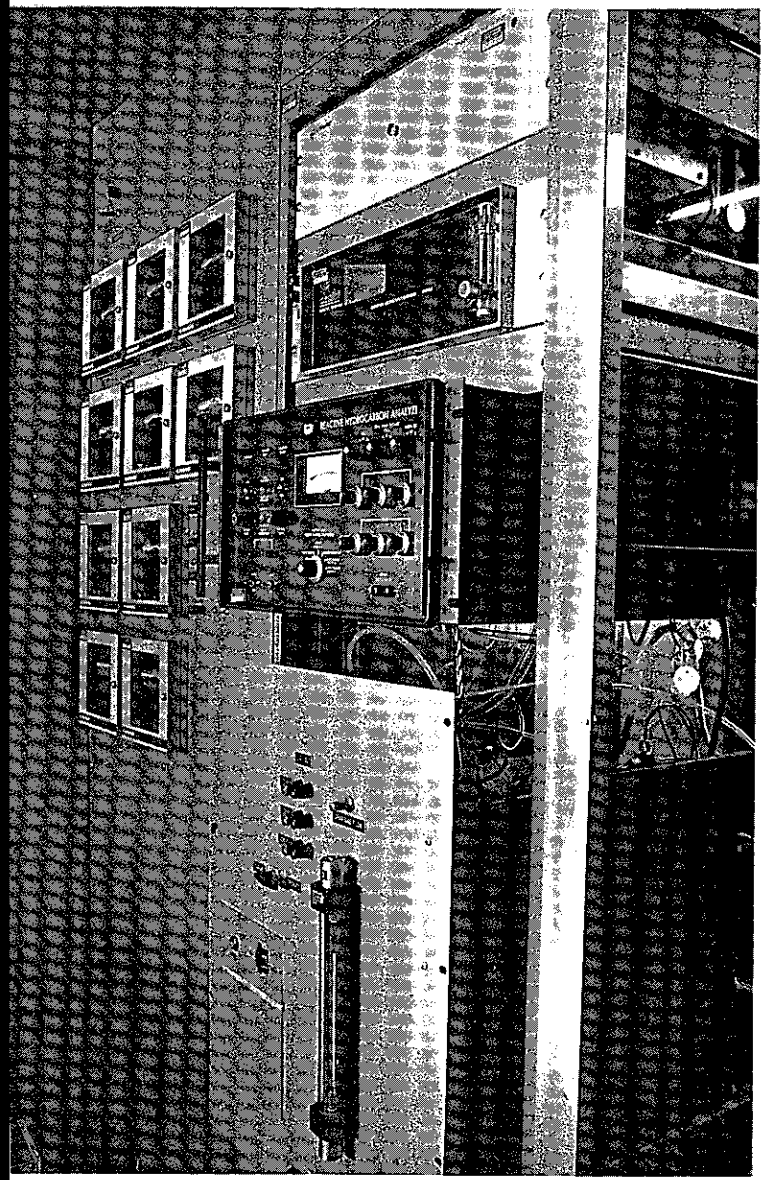

Fig. 6 Recorders and Main Instrument Rack with O_3 and the Analyzers

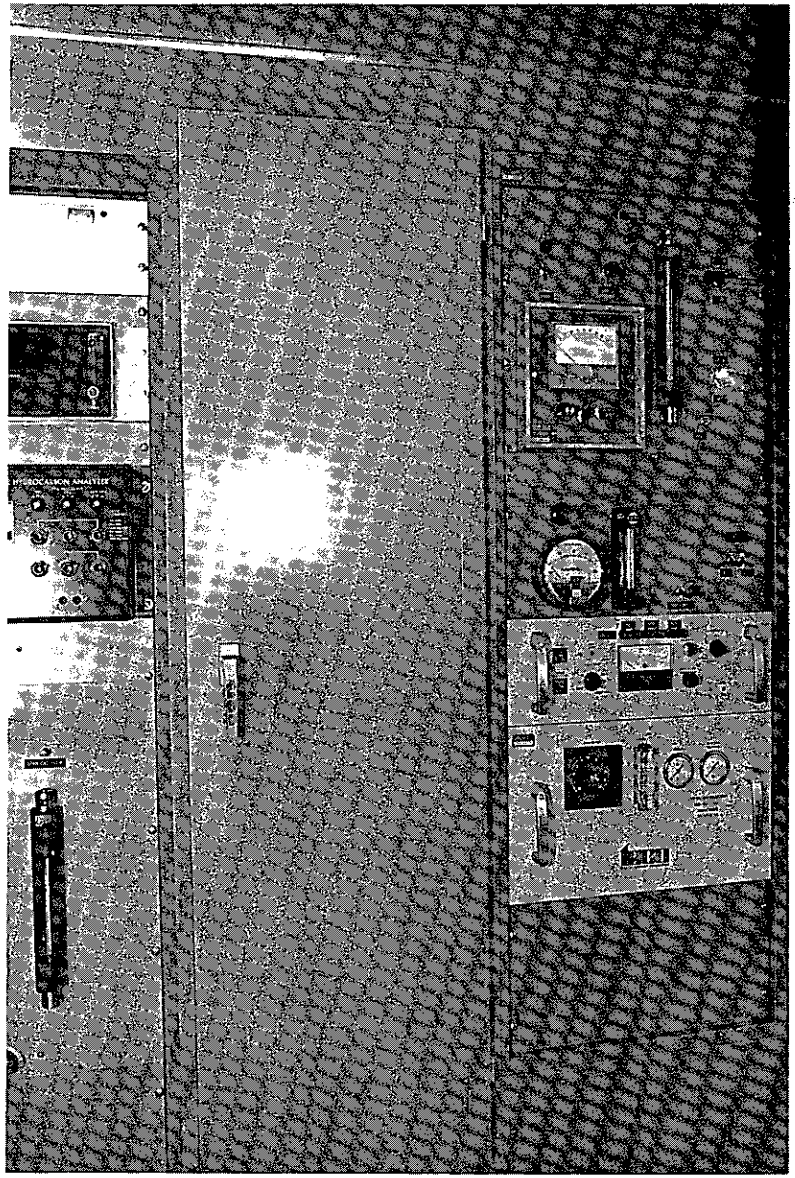

Fig. 7 Pass through door and CO & NO_x Analyzers

Behind the bulkhead is the support and service area. The instruments there are supported by open sided electronic instrument racks. Also located there are the following support systems and components:

1. Electrical circuits with outlets for all electrical equipment, pumps, recorders, etc.

2. All required analyzer vacuum pumps, driers, and plumbing for sample systems.

3. Main sample manifold.

4. Compressed air driers.

5. Calibration cylinder mounting racks.

6. Beckman Carbon Monoxide Analyzer.

7. AC Power Generator and housing with starting switch.

8. AC Power switching and breaker panel.

The main sample vacuum pump and the air compressor with receiver are mounted outside and under the van. The vacuum pump is just in front of the rear wheel on the passenger's side. The air compressor and receiver are in front of the rear wheel on the driver's side. These are mounted on brackets off the frame and have the necessary shields to prevent problems from wheel splash.

On the exterior of the van are mounted two separate mast assemblies. The sample intake mast, a two piece assembly with a 180° curve on the top section, is mounted on the passenger's side and extends above the roof a distance equal to the van height. The

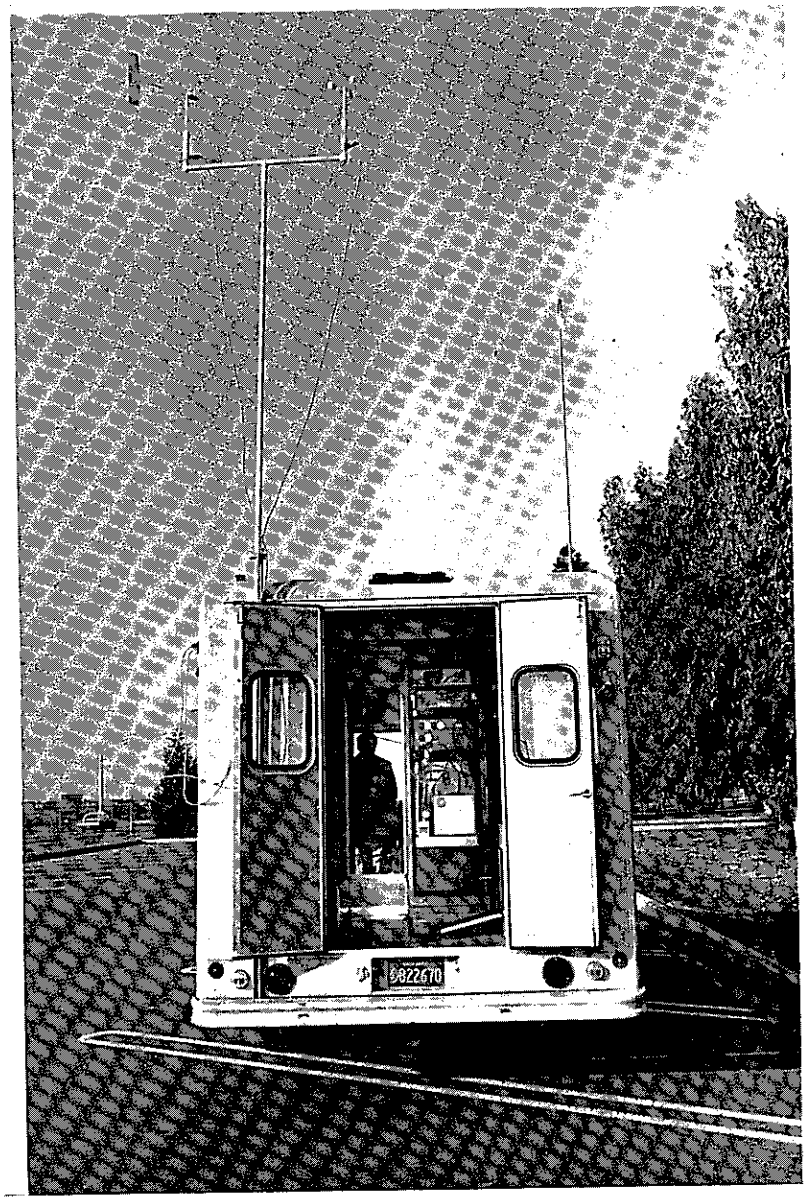

Fig. 8 Air Monitoring Van - Rear View

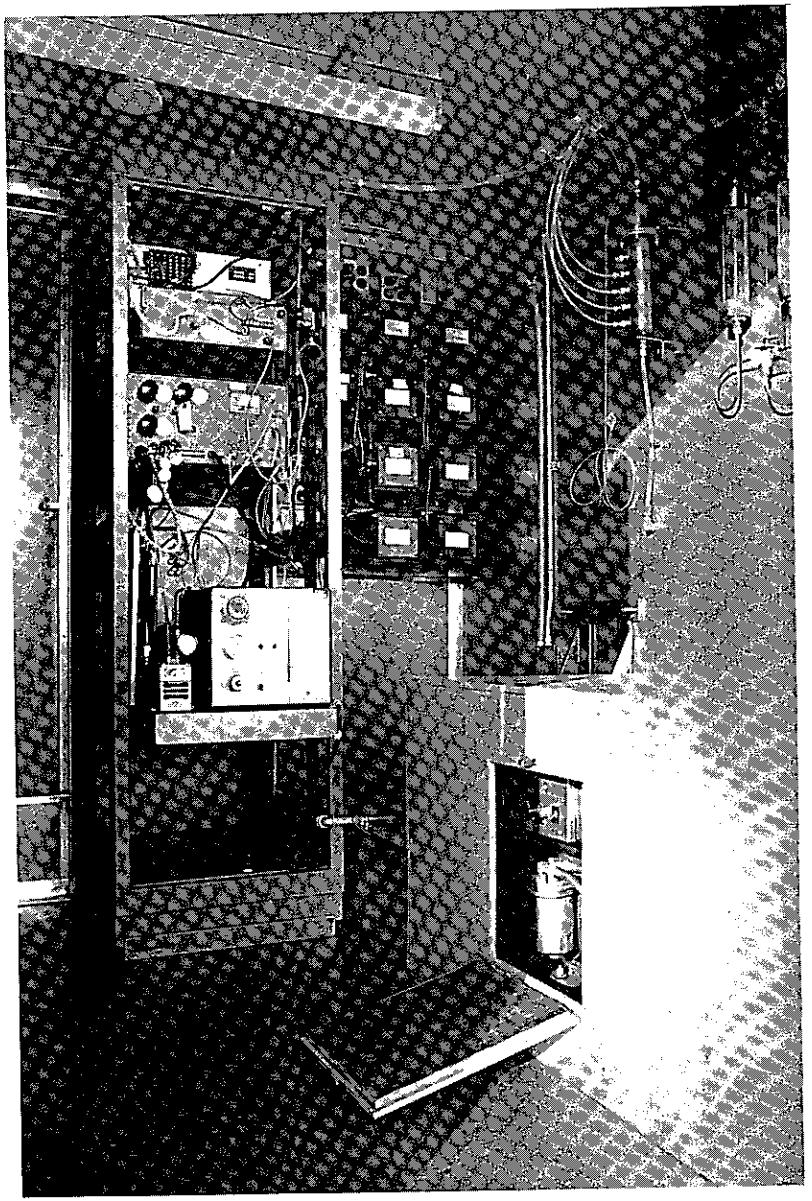

Fig. 9. Van Rear interior with Support Equip. and AC Generator

meteorological mast is also a two-piece assembly. One removable piece fits a second section which is permanently attached to the left rear of the van. By attaching the removable mast to a sliding section in the van mounted component, the effective height of the top of the mast is approximately one van height above the van roof. This allows all removable sections to be of such a length as to fit in the van in front of the bulkhead. The masts are light enough that one operator can set them up.

Other exterior modifications include vents for all analyzer exhausts to the outside, main sample inlet fittings, electrical signal plugs for wind speed sensors, and the cooling air inlet vent for the generator.

ANALYZERS

A brief description of each analyzer type and model used follows. These methods of analysis are the same as those used in the earlier mini-van and are described in the preliminary report*.

Carbon Monoxide (CO)

For CO analysis, a non-dispersive infrared (NDIR) device is used. It works on the principle of absorption of infrared light by CO at a specific wavelength. The instrument used is a Beckman Model 315BL with a 40 1/2 inch (103 cm) sample path length. It has a vibration sensitive detector and must be shock mounted to eliminate vibration from the generator or from other low frequency sources.

The other important interference is water vapor. In certain areas, such as the coast or bay region, a drier should be placed in the input sample line to insure elimination of this factor. Even though the analyzer has optics to greatly reduce problems of this nature, the addition of a drier is highly recommended.

The basic support system for this analyzer consists of:

1. a vacuum pump to supply the sample
2. a flow meter for measuring flow rates
3. a needle valve for flow control
4. a 5 way valve to direct sample, zero air, and two levels of span gases to the analyzer.

These components are built into the panel through which the instrument electronic controls mount.

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*Design and Development of a Mobile Air Quality Monitoring Van for Highway Environmental Impact Studies, Pinkerman, Ranzieri, Shirley, CAL-DOT-TL-7082-8-74-35.

In some cases a later model CO analyzer is used, the Beckman 865 NDIR. It operates on the same principle but has three basic differences. The sample path length is 15 inches (38 cm), the optics are designed to focus the infrared light to concentrate it, and the reference cell is a constant flowing reference scrubbed of CO. These design changes were intended to make the analyzer more compact, yet just as sensitive as the older long path model. One definite advantage is that the scrubbed air can be used as a zero reference and can eliminate one synthetic air cylinder required for instrument operation.

The model 865 needs a sample pump but is self-contained otherwise. It mounts through the panel much in the same manner as the electronic controls for the Model 315 BL. See Construction Drawing Appendix No. III. Calibration is performed by using a cylinder of 40-45 ppm CO in Nitrogen (N_2) to give a dynamic check on up-scale span. On long-term monitoring, an automatic calibration (zero and span) is recommended for the model 865 analyzer. This would compensate for its high drift characteristics. It would also be beneficial on the model 315BL analyzer when large temperature changes are experienced.

Oxides of Nitrogen (NO_x)

The analysis for NO_x is by the principle of chemiluminescence. In other words, the generation of light from the chemical reaction between instrument generated ozone and nitric oxide (NO) in the air sample. The amount of light measured, at a specific wave length, by a photomultiplier tube is proportional to the amount of NO in the air sample. To measure nitrogen dioxide (NO_2), a reducing catalyst changes the NO_2 to NO and the instrument reads the total reaction. This gives a NO_x value and, when the original NO value is subtracted, results in a NO_2 value.

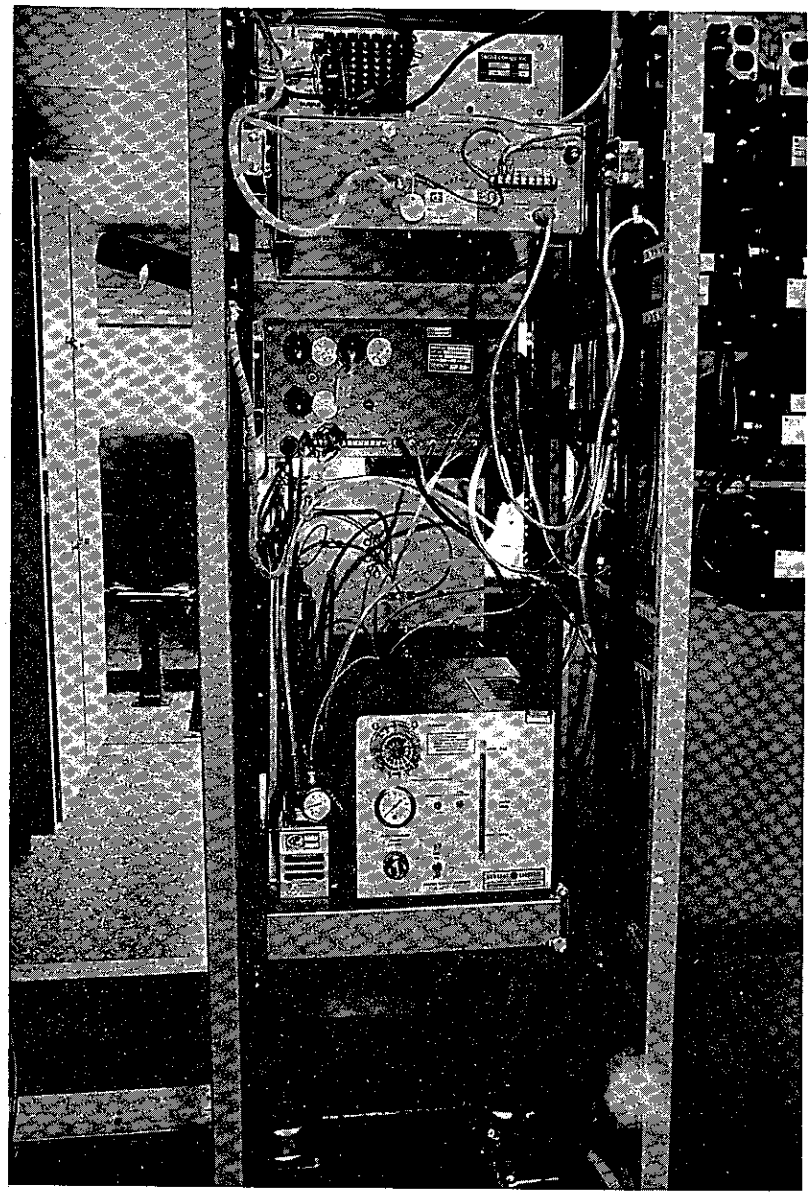

Fig. 11 Main Instrument Rack Rear View

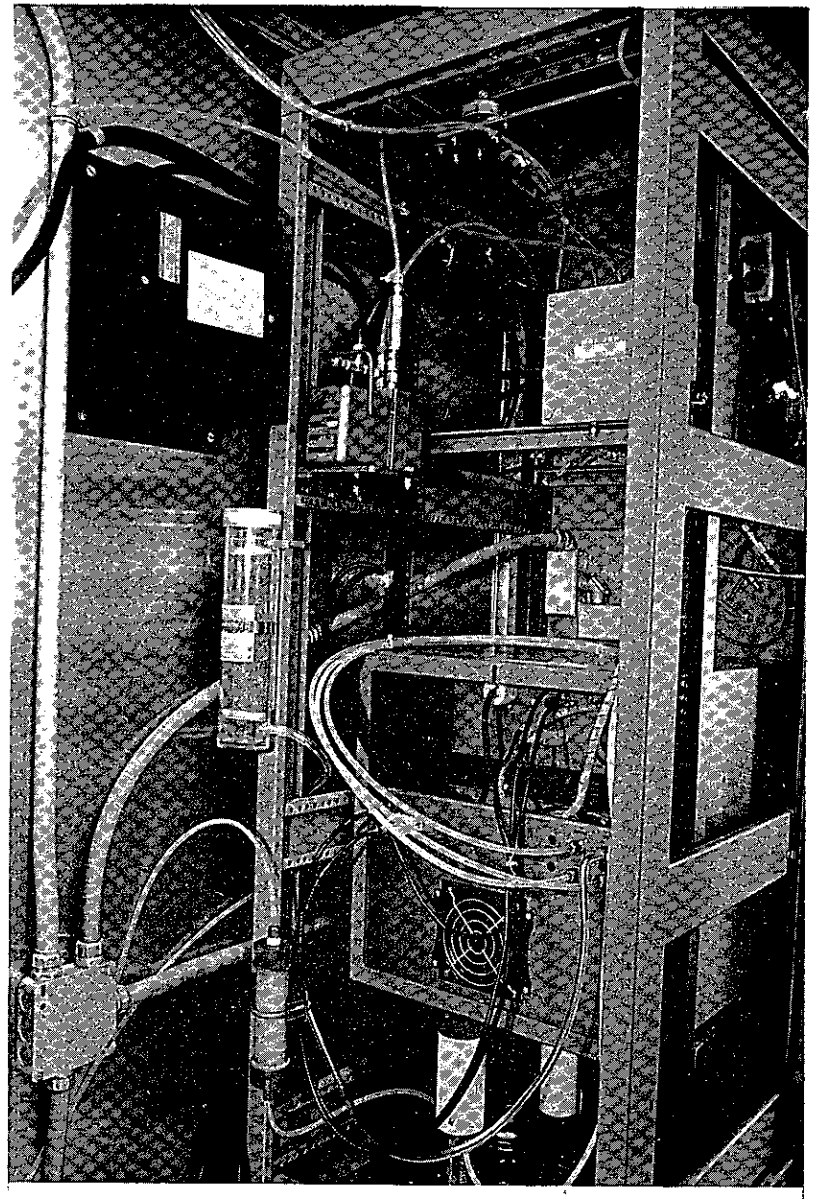

Fig. 12 Rear View - Left Rack CO & NO_x Analyzers

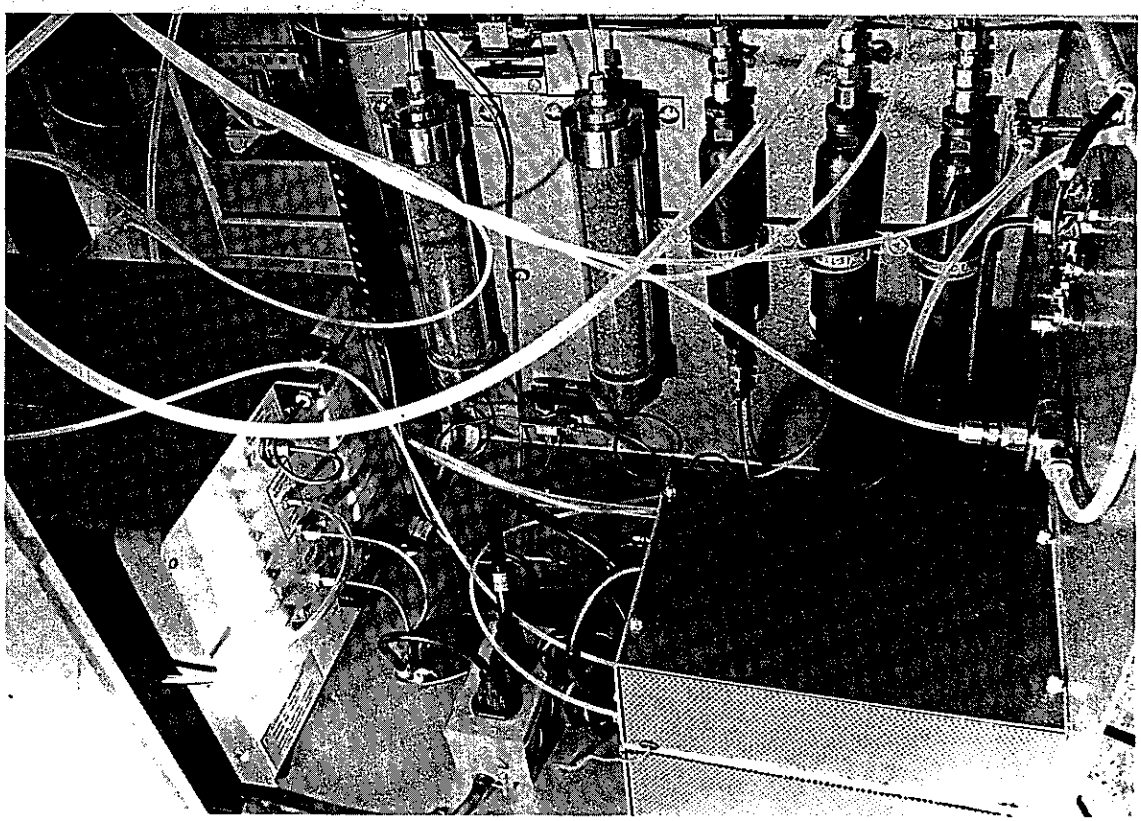

Fig. 13 The Analyzer Support Equipment H_2 Generator, Driers, Clean Air Package

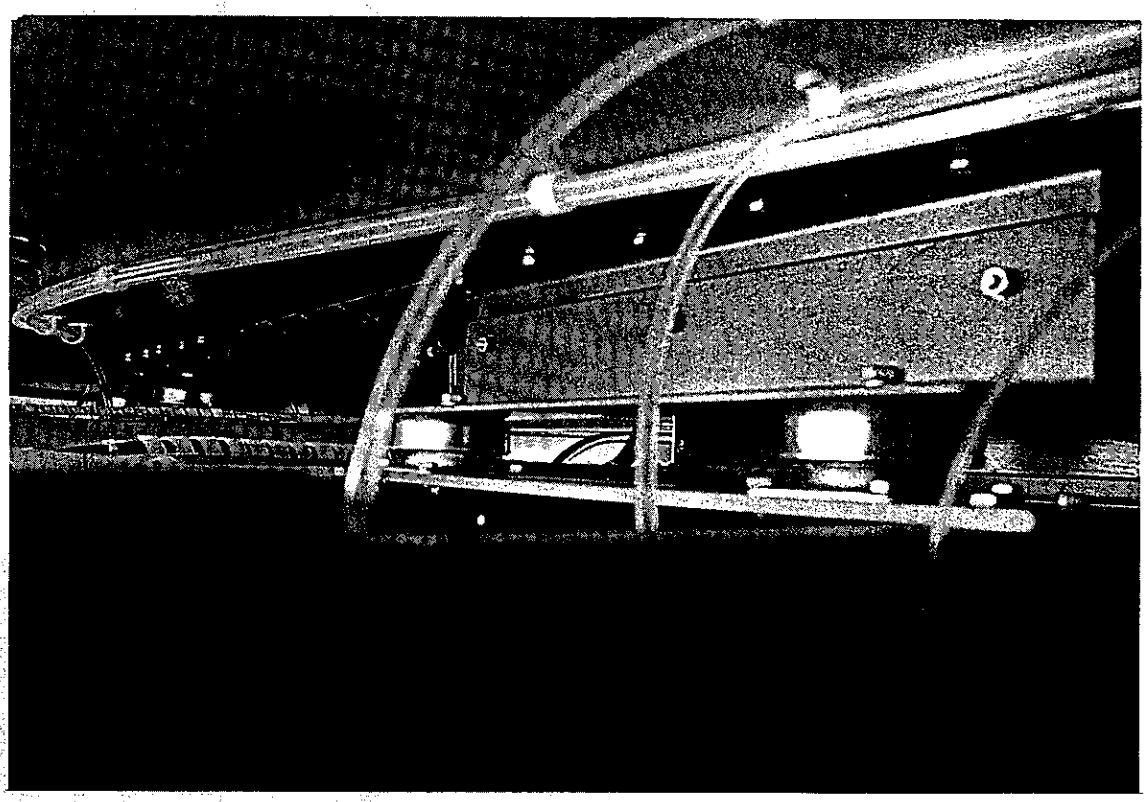

Fig. 14. Top Rack Mounts

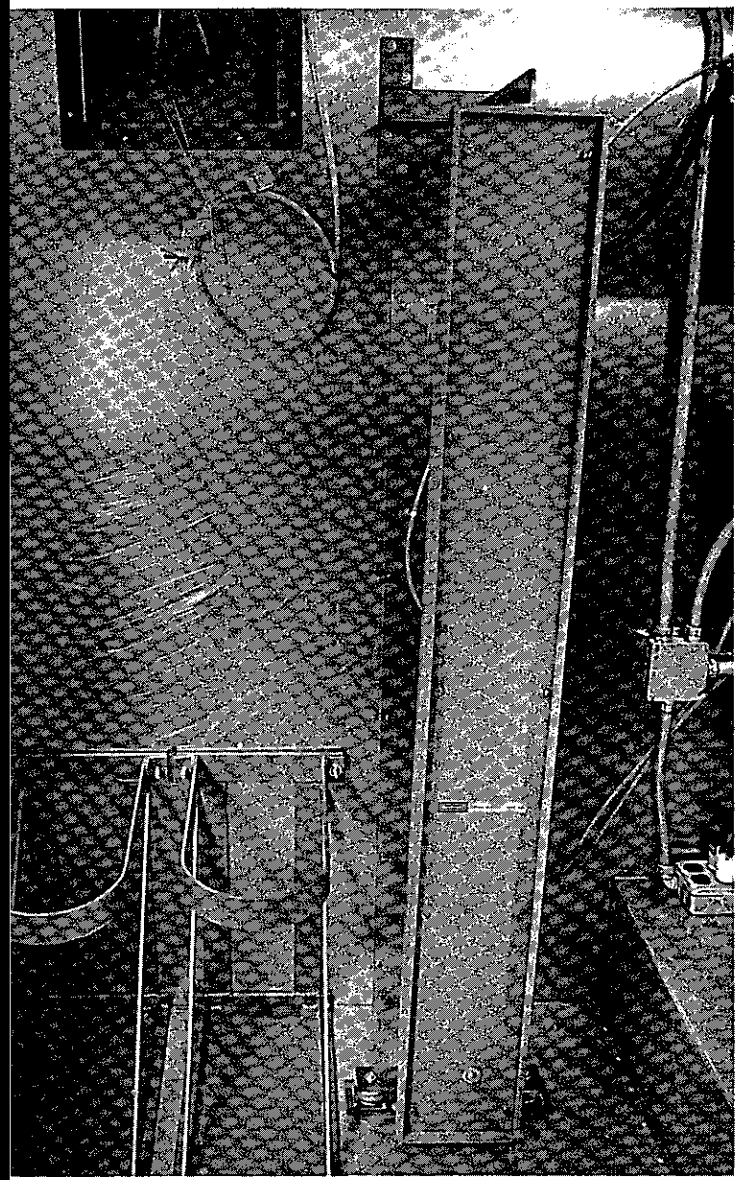

Fig. 15 CO Analyzer Sample Cell Chamber & Racks for Span Gas Cylinders

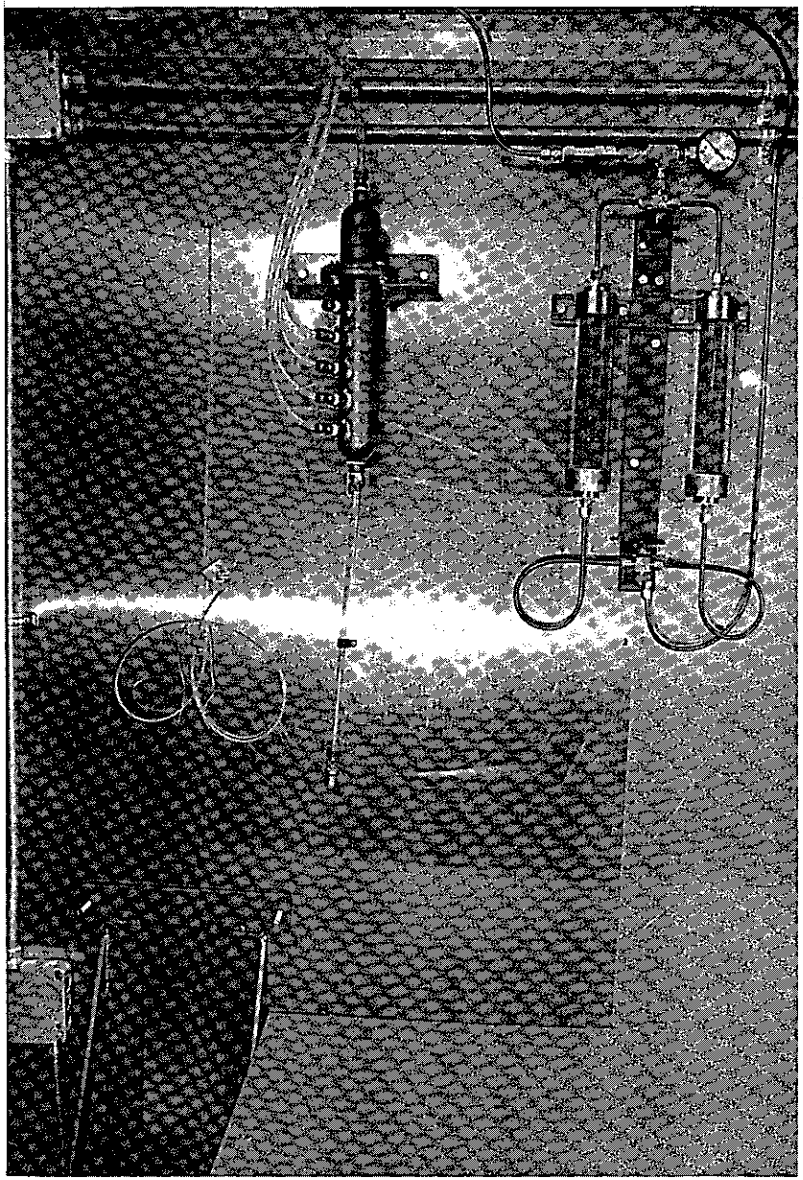

Fig. 16. Sample Manifold, Air Supply Driers and the Span Gas Cylinder Rack

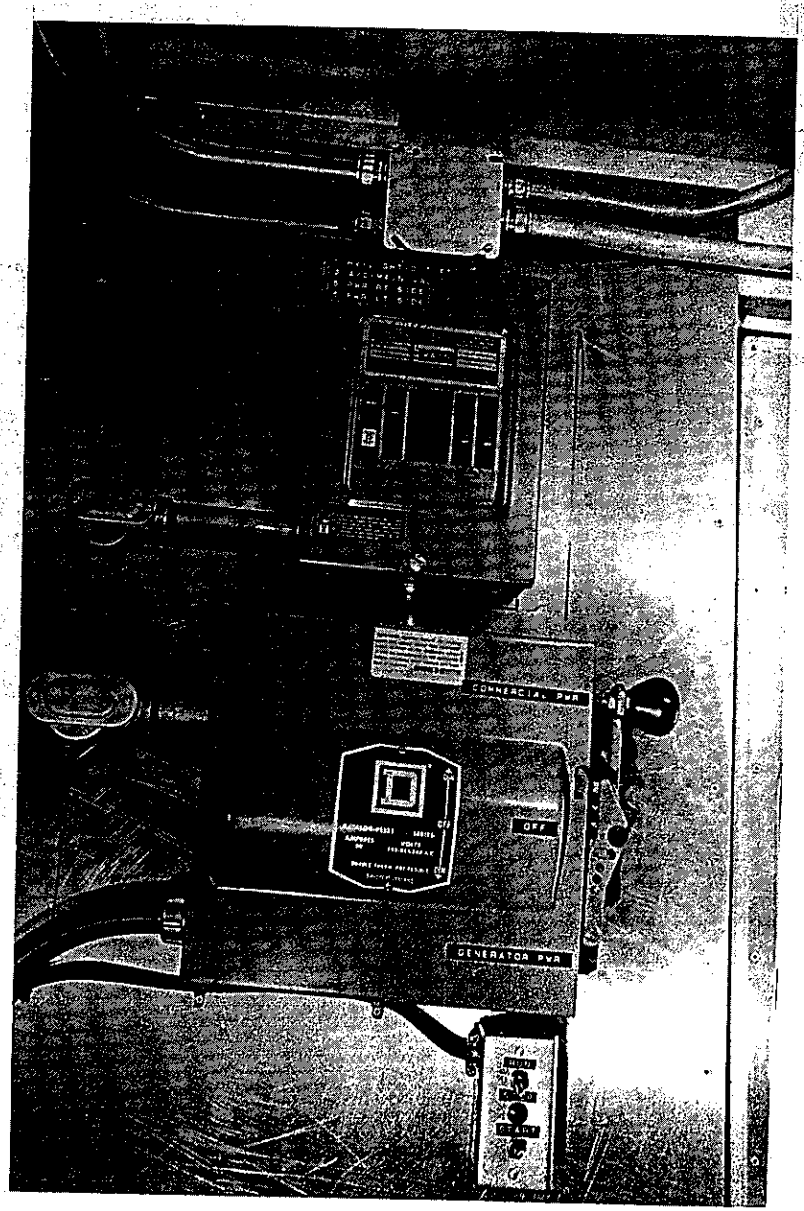

Fig. 17 Electrical Power Panel

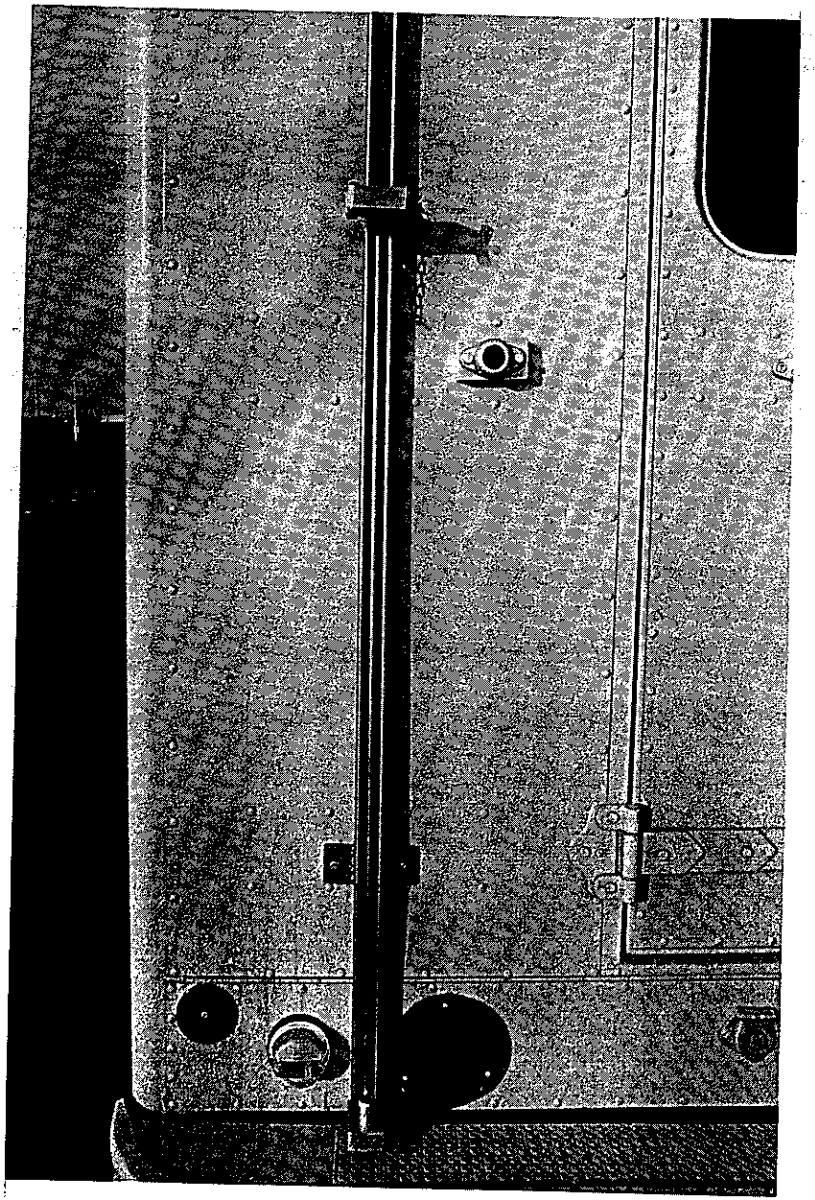

Fig. 18. Meteorological Mast Mount

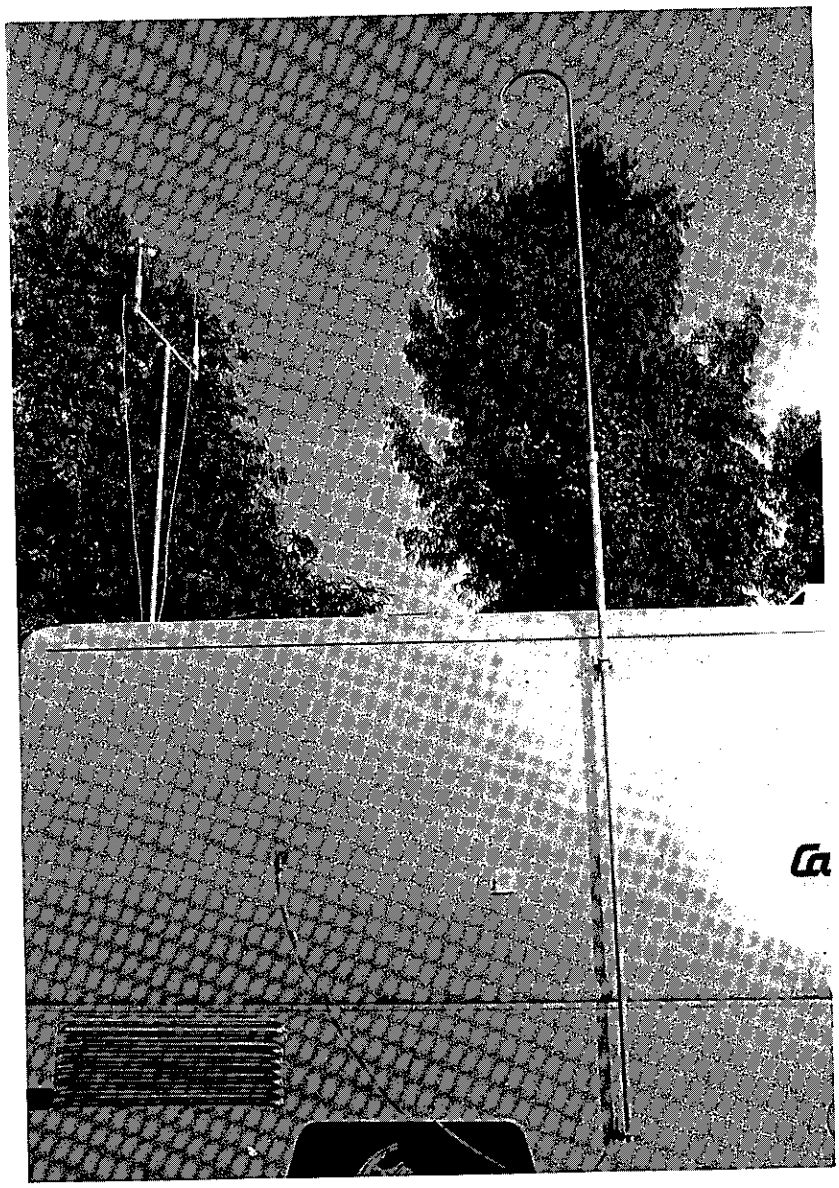

Fig. 19. Air Sample Mast

The Thermoelectron Model 14B NO_x analyzer is complete with necessary pumps and flow meters for operation. The unit is mounted in the rack over the driver's side wheel well. The two vacuum pumps (one sample, one chamber) are located on the wheel well directly behind the electronic enclosure. Two items that are necessary for operation are the silica-gel drier for the air intake to the ozonater and the charcoal filter on the exhaust to the main vacuum pump.

The first insures dry air to the ozonator and the second prevents dumping elevated ozone concentrations back into the outside air. Calibration is performed using a cylinder of 3-4 ppm NO in nitrogen to give a dynamic check on up-scale span. Zero is established by shutting off the ozone supply or by using a scrubber to remove NO and NO_2 from the ambient air.

Ozone (O_3)

A Dasibi 1003 AH ultraviolet light (UV) absorption type analyzer is used for measuring ozone (O_3). This device works on the principle of absorption of UV, at a specific wave length, in proportion to the amount of O_3 in the air sample. This instrument is self-contained including sample flow meter and pump. It requires only an inert sample supply system (preferably teflon or glass, with limited stainless steel) as ozone reacts with all but the most inert materials.

The Dasibi has an internal electronic calibration system to test degradation of the UV light source and to check for optical contamination by dirt. Span and linearity are tested using an ozone generator.

This analyzer is mounted in the central instrument rack on guide rails which allows easy removal and maintenance.

Hydrocarbons (THC) (CH_4)

A gas chromatograph (G.C.) is used to measure total hydrocarbons (THC), methane (CH_4), and reactive hydrocarbons (RHC). These components are separated by chromatographic techniques and detected by a hydrogen flame ionization detector (FID).

Dry, pure hydrogen and compressed air are required as support gases. The air is scrubbed by a thermal converter to eliminate ambient hydrocarbons and is used as a carrier through the chromatograph's columns. Compressed air is also supplied to support the hydrogen flame.

The analyzer is rack-mounted on drawer slides and is chained to a support tray that is mounted directly below it. The support tray contains the clean air package, the hydrogen generator, drier assemblies, and finally, the molecular sieve clean up driers. This drawer assembly is chained, for safety reasons, to the gas chromatograph to eliminate the bending and working of the copper tubing that conducts hydrogen to the analyzer thus minimizing the chance of hydrogen leakage.

The hydrocarbon analyzer is calibrated using a cylinder of methane in synthetic air (4-5 ppm) and a cylinder of propane in synthetic air (20-30 ppm).

Particulate Sampling

A provision has been made for exterior AC power for the operation of a High Volume (hi-vol) air sampler. See Calif. Test Method No. 706-A for operation and calibration specifics. The "hi-vol" air sampler is not a standard part of the air monitoring vans, it is designed as an optional attachment.

METEOROLOGICAL SENSORS

A Wind Speed (Model 010) and Direction Sensor (Model 020) along with a TechEcology Model 100 translator are provided with each van. The sensors are mounted on a 13 foot (4 meters) mast on the left rear corner of the van.

These sensors are electronic and convert the mechanical motion to an electrical signal. The wind speed sensor uses a light beam chopper wheel mounted to the cup shaft to generate a frequency signal in proportion to the wind speed. This signal is converted by the translator card to a voltage signal of 0-1 volt to drive a strip chart recorder. The wind direction sensor head moves the shaft of an electrical potentiometer which varies resistance in proportion to degrees of direction change. The translator converts this to a 0-1 volt output to drive the strip chart recorder. A special circuit handles the signal switching when the potentiometer null point is passed. This is necessary in a single potentiometer system to prevent chart painting when wind direction changes occur continuously over the null point.

The wind direction sensor is oriented by sighting with the aid of a compass across the cross arm mounting for the sensors. When set with the wind direction sensor on the north end of the arm and corrected for declination, the sensor will read true direction of wind flow.

The translator has built-in capability for adding other sensors up to six total. In addition it has basic electronic "span and zero" test functions.

The outputs from these sensors are placed on two separate recorders for permanent record.

Calibration of these sensors is performed in a wind tunnel for wind speed and with a degree wheel for wind direction.

DATA ACQUISITION

Data are taken on Easterline Angus 4 inch (10 cm) chart recorders, one for each parameter measured. These recorders use Z-fold type paper and provide an economical record of data.

The recorder panel (see Figure 5) is constructed with span and zero test functions and adjustment. Built-in input jacks are provided so that calibrated DC voltages can be used to test and calibrate the recorders. The analog signal coming into the recorders is either 0-100 mv, 0-0.5 volt and 0-1.0 volts DC and the recorder electronics were modified to accept these ranges. All signal lines are shielded and the shields are gounded.

Separate switching and fusing is built into the panel for the group of recorders for versatility of operation. In addition there are parallel signal jacks on the front of each analyzer so that an auxillary 10 inch (25 cm) chart recorder can be used for calibration setup or for trouble shooting.

In the future it is planned to add a magnetic tape data acquisition device. Space is provided in the panel for this equipment.

CALIBRATION

The primary calibration for this system is performed quarterly by the Air and Industrial Hygiene Laboratory (AIHL), California Department of Health. Their calibration procedures are based on accepted EPA reference methods.

"Zero" air, as used in the following discussion, is synthetic air free from traces of carbon monoxide, hydrocarbons, or oxides of nitrogen.

Span gas is some specific concentration of the pollutant added to pure nitrogen or synthetic air. The concentration is usually about 80% of full scale of the most commonly used analyzer range. Other pollutant concentrations can be used near mid-range to check linearity.

The van calibration system is designed to be used at regular intervals (daily-weekly) for secondary calibration. This consists of in-use "zero" and up-range "span" checks. The carbon monoxide, oxides of nitrogen, and total hydrocarbon analyzers are calibrated with bottled gases carried on board. These gases are given concentration values by the Transportation Laboratory, Enviro-Chemical Branch, or by AIHL. The values are determined by analysis using an analyzer set up with "gold bottle standards"; this gives all satellite analyzers a common baseline.

The "gold bottle" values are derived from analysis performed by the California Air Resources Board Laboratory and by the Air and Industrial Hygiene Laboratory (AIHL), and are referenced to standard research materials produced by the National Bureau of Standards.

For carbon monoxide analyzer calibration, the van carries "zero" air and span gas of 40 to 45 ppm carbon monoxide in dry nitrogen for 0-50 ppm range span gas.

The hydrocarbon analyzer is spanned with bottled gas calibrated by AIHL. It consists of methane and propane in air; concentrations vary so as to be comparable to local ambient levels. Normally this will vary from 4.5 to 5 ppm methane and 25 to 30 ppm total hydrocarbons.

The oxides of nitrogen analyzer utilizes a scrubber, as mentioned previously, to obtain "zero" air and uses 3-4 ppm nitric oxide in nitrogen as a span gas.

All bottled gas systems require regulation to supply gases at working pressures. All regulators are two stage stainless steel diaphragm oxygen service type. It is essential to coordinate fittings on bottles (from private leaser - gas supply house) to those required by regulations for safety; CGA* 350 for carbon monoxide, CGA 580 for nitrogen, etc.

The ozone analyzer is checked monthly with an ozone generator to determine system operation and accuracy.

The ozone is generated by exposing an air stream in a quartz tube to short wave ultraviolet light at 1849A°. The concentration is varied by shielding the lamp with a retractable shield which is marked in 5 mm (.02 in.) increments for reproducible settings.

The incoming air should be dry and ozone free. A simple charcoal or molecular sieve filter will perform both functions.

Ozone decomposes readily on most surfaces. Care should be taken to change the filter frequently, if one is used, and to ensure that the sample lines to the instrument are clean and of a material such as glass or teflon which is inert to ozone.

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*CGA - California Gas Association Code for regulator to cylinder stem fittings.

Field checkout is accomplished by plotting a curve comparing ozone output from the generator with the analyzer reading. This is done when the analyzer has its first "primary calibration" by the Air and Industrial Hygiene Laboratory, and then is checked monthly during field operation. Deviation in excess of .02 ppm indicates need for re-calibration. The life of a pen-ray lamp is very long (10,000 hours) at a relatively constant output, therefore it provides a good check system. The analyzer itself has an internal electronic check system to monitor deterioration of its internal light source, related electronics, or clouding of the optics due to settlement of particulates. (See Section on ozone analyzer for principle of operation.)

The calibration methods and support gases are listed in Table I.

The meteorological sensor is factory calibrated on delivery and is periodically re-calibrated in the Transportation Laboratory wind tunnel at the wind speeds observed during normal monitoring conditions (40 mph (64 Kph) and below).

The Hi-Vol particulate sampler is calibrated for air flow according to the test method*.

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*Methods of Air Sampling and Analysis - Intersociety Committee American Public Health Association, 1972.

FIELD EXPERIENCE

There have been 9 vans constructed of this design to date. Some minor component location variations have come about but the basic design has proven quite serviceable.

Field problems have centered around the need for additional air conditioning and, with the second air conditioner, the need for more AC power generator capacity. The second air conditioner readily seems to maintain van temperatures at 80°F (27°C) or below on days of 100+ (38°C) ambient temperature.

Instrument and support system problems have been few. When failure does occur, the problem is usually a manufactured component.

TABLE I

ON-BOARD CALIBRATION METHODS AND SUPPORT GASES

Analyzer	Method	Gases Required	Cylinder Size	Cylinder Life
CO	(NDIR) Bottled Gases	Zero & Span Air	80 cu.ft. Air 65 cu.ft. Span	2 months 2 months
O_3	(UV) O_3 gen.	None		
NO_x	(Chemiluminescent) Bottled Gas	NO Span Oxygen	80 cu.ft. NO 100 cu.ft. O_2	2 months 2 months
Hc	(G.C.-FID) Bottled Gases	CH_4 Span	80 cu.ft. CH_4 Span	2 months

*Volume at 1600-2000 psi

APPENDIX I

ANALYZER LIST, PRICES, & MANUFACTURER'S ADDRESSES

ANALYZERS	MANUFACTURER/MODEL	APPROX. COST
Carbon Monoxide	Beckman Instruments Process Inst. Division 2500 Harbor Blvd. Fullerton, CA 92634 NDIR Model 315BL or Model 865	$ 4,500
Ozone	Dasibi Environmental 616 E. Colorado St. Glendale, CA 91205 Model 1003AH	4,500
Oxides of Nitrogen	Thermo Electron Corp. 85 First Avenue Waltham, Mass. 02154 Model 14B	6,000
Hydrocarbons	Bendix Instruments Process Inst. Division Drawer 477 Ronceverte, WV 24970 Model 8201	5,500
Meteorological Sensor	TechEcology 645 No. Mary Ave. Sunnyvale, CA 94086 Models 010, 020, and 100	2,500
Hi-Vol Sampler	Misco Scientific 1825 Eastshore Highway Berkeley, CA 94710 Curtin Model 1251-223	500

ANALYZERS	MANUFACTURER/MODEL	APPROX. COST
Support Equipment		
Recorders	Esterline-Angus 137 N. Puente Avenue City of Industry, CA 91746	$ 300
	Mini Servo MS 410 C-14-115-61-LT	
File Unit & Apron One Drawer	Permalab Equip. Corp 999 Rancho Conejo Blvd. Newbury Park, CA 91320	300
Valves	Whitey Valves	
	Example: 18VF8 1/8" FPT Brass	30
	Oakland Valve & Fitting Co. 2487 Estand Way Pleasant Hill, CA 94523	
Calibration Gases	Example:	
	85 ppm CO in Dry Nitrogen #80 size bottle	40 each
	Airco Specialty Gases 575 Mountain Avenue Murray Hill, NJ 07974	
Regulators	Two-Stage Pressure Regulators Victor VTS-400D	55 each
	Victor of California P. O. Box 15070 Sacramento, CA 95813	
Instrument Shock Mounts	Barry Cupmounts C4100-T10, C-2090-T6, and C-1050-T4	10 to 20 each
	Barry Controls 2323 Valley Street Burbank, CA	

ANALYZERS	MANUFACTURER/MODEL	APPROX. COST
Filters	Hoke Model #6315-F2B inline Micron Filter	$ 10 each
	Con-Val 412 Pendleton Way Oakland, CA 94621	
Ground Fault Interrupter	(20 amp) Breaker Type	50
	Graybar Electrical Supply	
Vacuum Pumps	Metal Bellows Corp. 20977 Knapp Street Chatsworth, CA 91311	80
	Model MB-21	
Vacuum Pump Compressor	James Wilbee Co. 420 Market Street San Francisco, CA 94111	100
	Gast Model 0211-103A-G8C Gast Model 1HAB-11-M100X	250
Generator	King Knight Co. 6202 Christie Avenue Emeryville, CA 94608	1,500
	Kohler (Motor Home Type) Model 5MC21	
Flow Meters	Fischer-Porter #10A3565A tube size to flow requirements, stainless steel fittings	150
	G. M. Cooke Associates 935 Pardee Street Berkeley, CA 94710	
Fittings	Swagelok (Stainless Steel & Brass) Various types & prices	
	Oakland Valve & Fitting Co. 2487 Estrand Way Pleasant Hill, CA 94523	

ANALYZERS	MANUFACTURER/MODEL	APPROX. COST
Instrument Rack	Budd 60-2510 60-2511 Sacramento Electronics 1219 S Street Sacramento, CA 95816	160.00 180.00
Tubing	Teflon (FEP Type) 1/4" & 3/8" O.D. The Fluorocarbon Co. 550 Ellis Street Mountain View, CA 94040	.95 & 1.50/ft.
H2 Generator	G. E. Scientific West Coast Rep. Western Scientific P. O. Box 698 Danville, CA 94526	2,500

APPENDIX II

CONSTRUCTION CRITERIA AND COMPONENT DETAIL DRAWINGS

Van Construction

This appendix contains the basic information necessary to lay out the subsystems and the necessary fabricated components. Line drawings, parts lists and some narrative are provided for guidance.

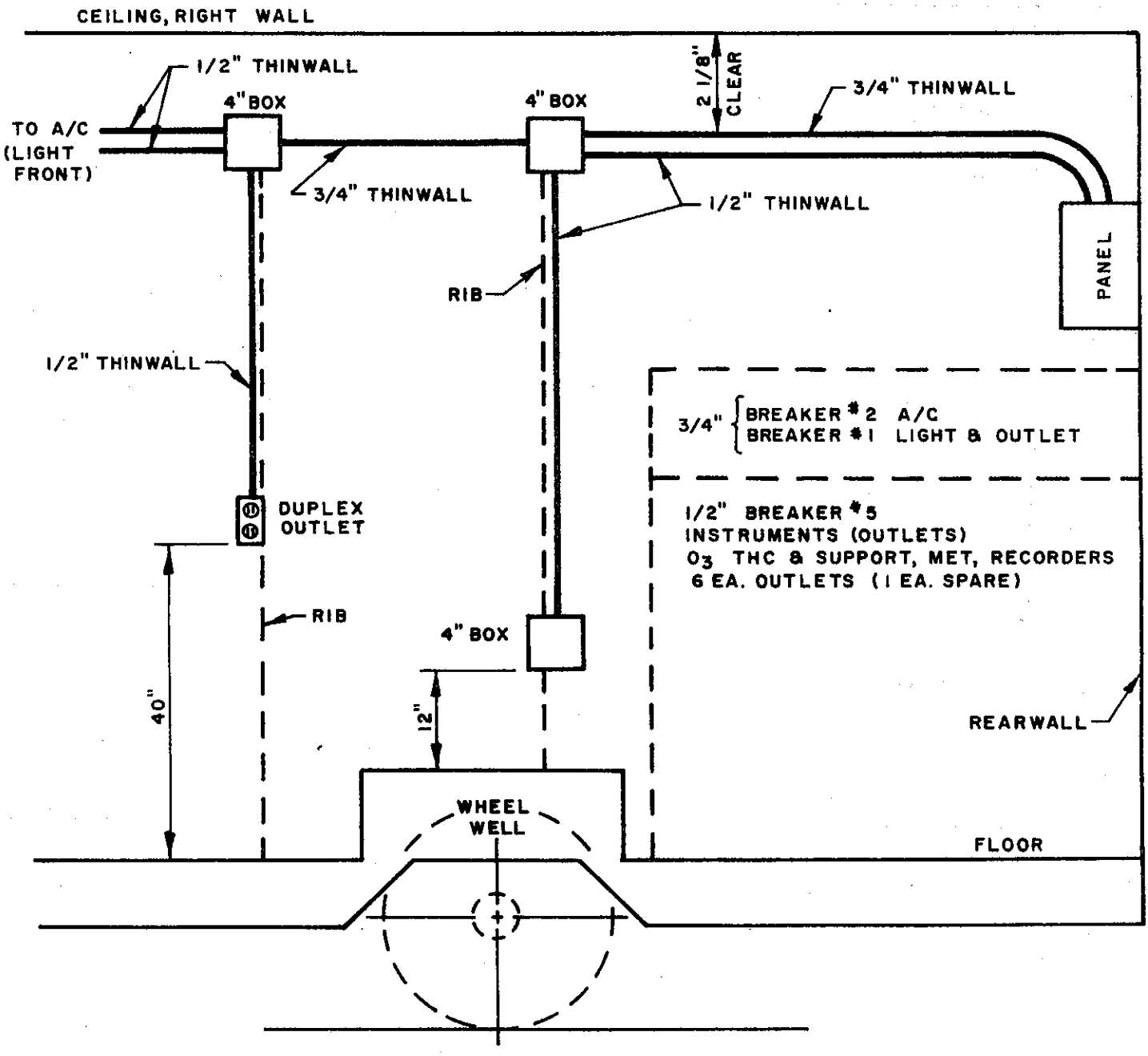
Electrical Power Wiring

Power for van instrumentation is from either an onboard generator or commercial power connection. A knife switch on the right rear panel allows the selection of power from the outside line power (220 V-AC - 20 amps, split into 2 circuits 110 V-AC 20 amps each) input connector or from the gasoline powered 5000 watt 220/110 V-AC generator. The power is then wired to a breaker box including one ground fault interrupter (GFI) breaker for outside AC receptacles.

All components requiring AC power are connected to the main breaker panel in the right rear corner of the van. See Figures 22, 23, and 24. Instruments, pumps, and recorders are wired using receptacles and plug in service cords. The receptacles are fused and switched (as necessary) from the front of the bulkhead near the appropriate instrument. Main vacuum pump and air compressor switches and fuses are located on the main flow panel.

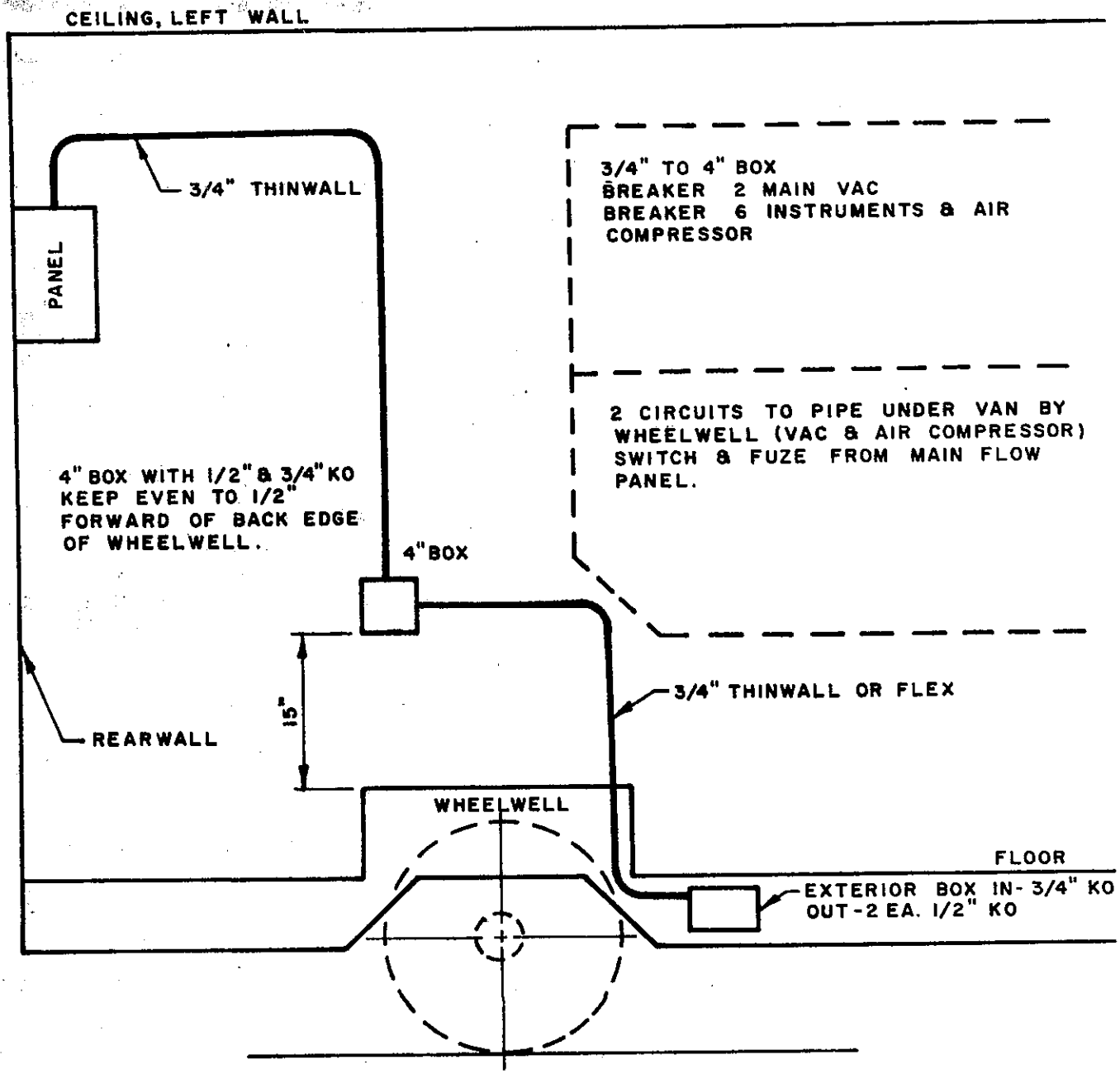
All wiring is in thinwall conduit (EMT) except for service cords for particular instruments. Circuit loads are divided up as shown on figure 24. Note wire sizes and mechanical grounds.

Power Right Side - Run conduit as per Figure 20 and locate outlets and junction boxes as noted. Breaker #1 is for lights, desk outlet, and exterior outlet. Breaker #2 in the main panel is for Air Conditioner power and this circuit should be wired with No. 12 wire. Breaker #5 provides power to the recorders and the central instrument rack. There is one main



ELECTRICAL POWER

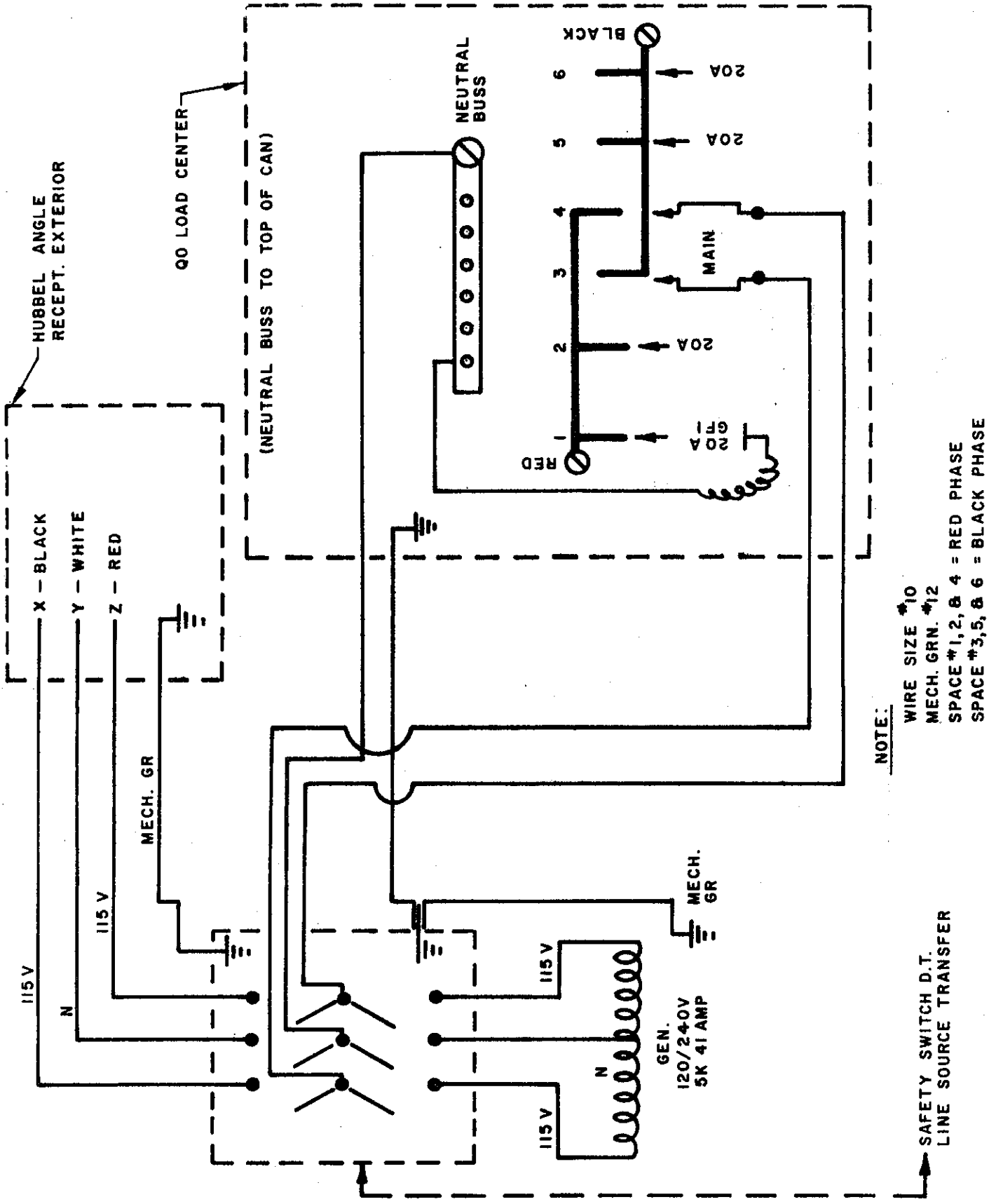
Figure 20



INSTRUMENT OUTLETS - 6 EA.
CO-2 EA.-SWITCH PUMP OUTLET, IF 865 SWITCH BOTH OUTLETS.
(SWITCH & FUZE-CO PANEL)
NOX-1 EA.
NOX PUMPS-2 EA.-SWITCH & FUZE FROM MAIN FLOW PANEL.
SPARE-1 EA. OUTLET.

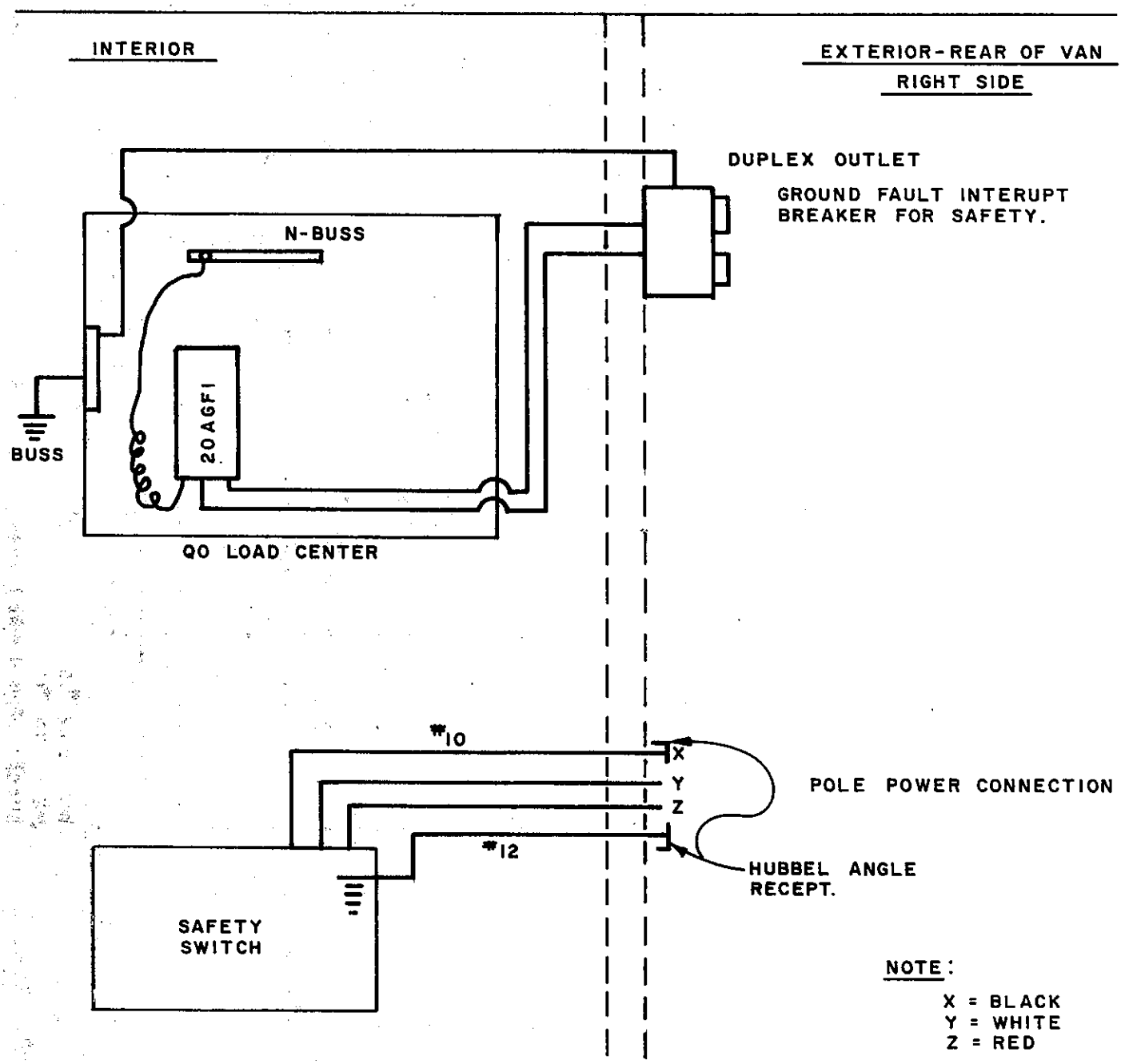
ELECTRICAL POWER

Figure 21



ELECTRICAL POWER

Figure 22



ELECTRICAL POWER

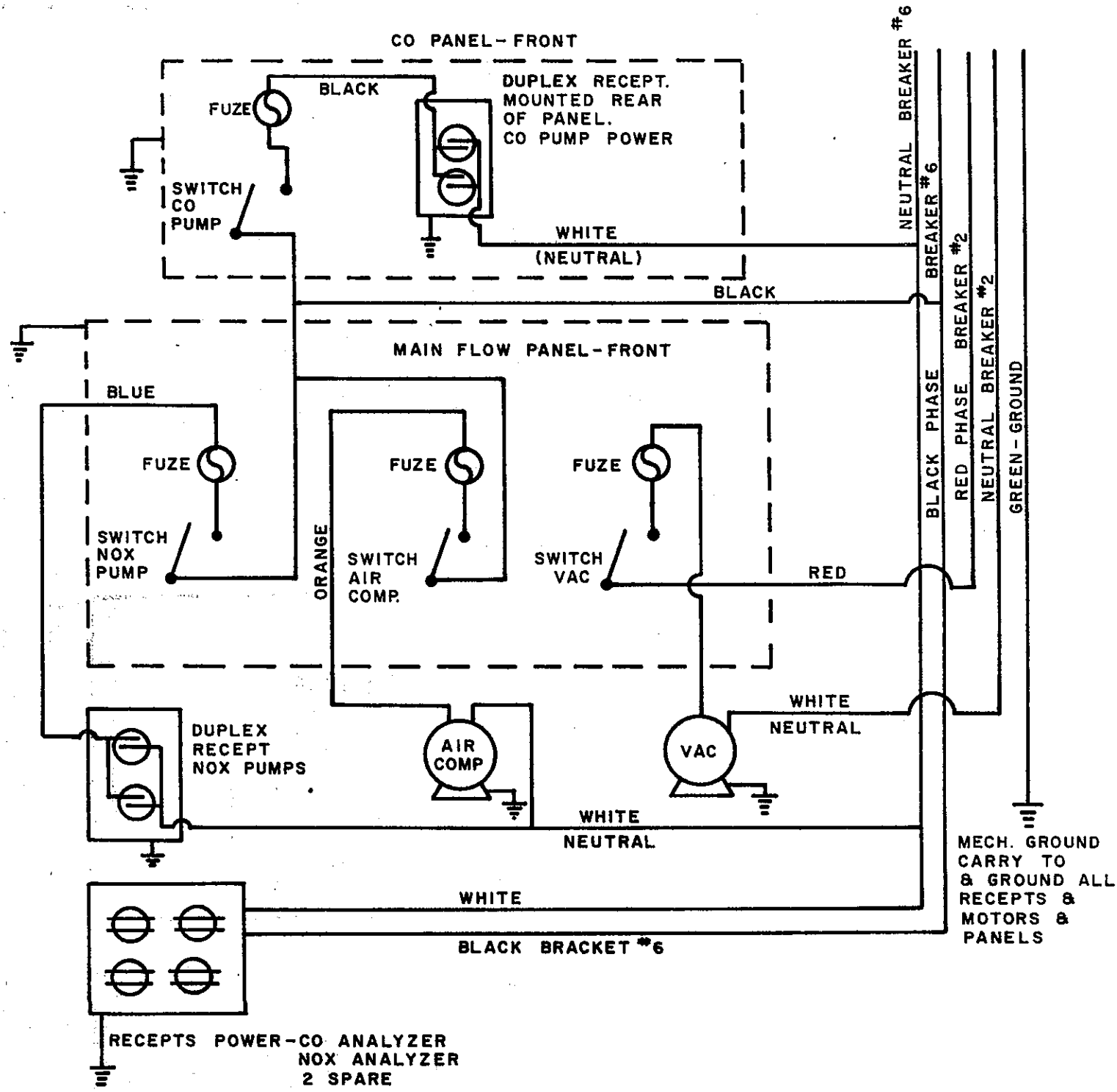
Figure 23

PHASE	BREAKER	BLACK = X PHASE ON THE 115V, 12/3 POWER CORD LOAD
BLK	3	MAIN
RED	4	
"	1	HI-VOL-LIGHT-OUTLET
"	2	A/C & MAIN VAC
BLK	5	POWER-RIGHT SIDE
"	6	POWER-LEFT SIDE
"	5	
"	5	
"	6	
"	6	

POWER CORD CONNECTION TO HUBBEL EXTERIOR ANGLE RECEPT
120/240V 1 Ø POLE SERVICE 10/4 SQ HEAVY DUTY CORD X - BLACK - 115V Y - WHITE - NEUTRAL Z - RED - 115 V GR ⏚ - GREEN
120V SERVICE CORD 12/3 SQ HEAVY DUTY CHORD X - BLACK - Y - WHITE - NEUTRAL Z - NO CONNECTION GR ⏚ - GREEN

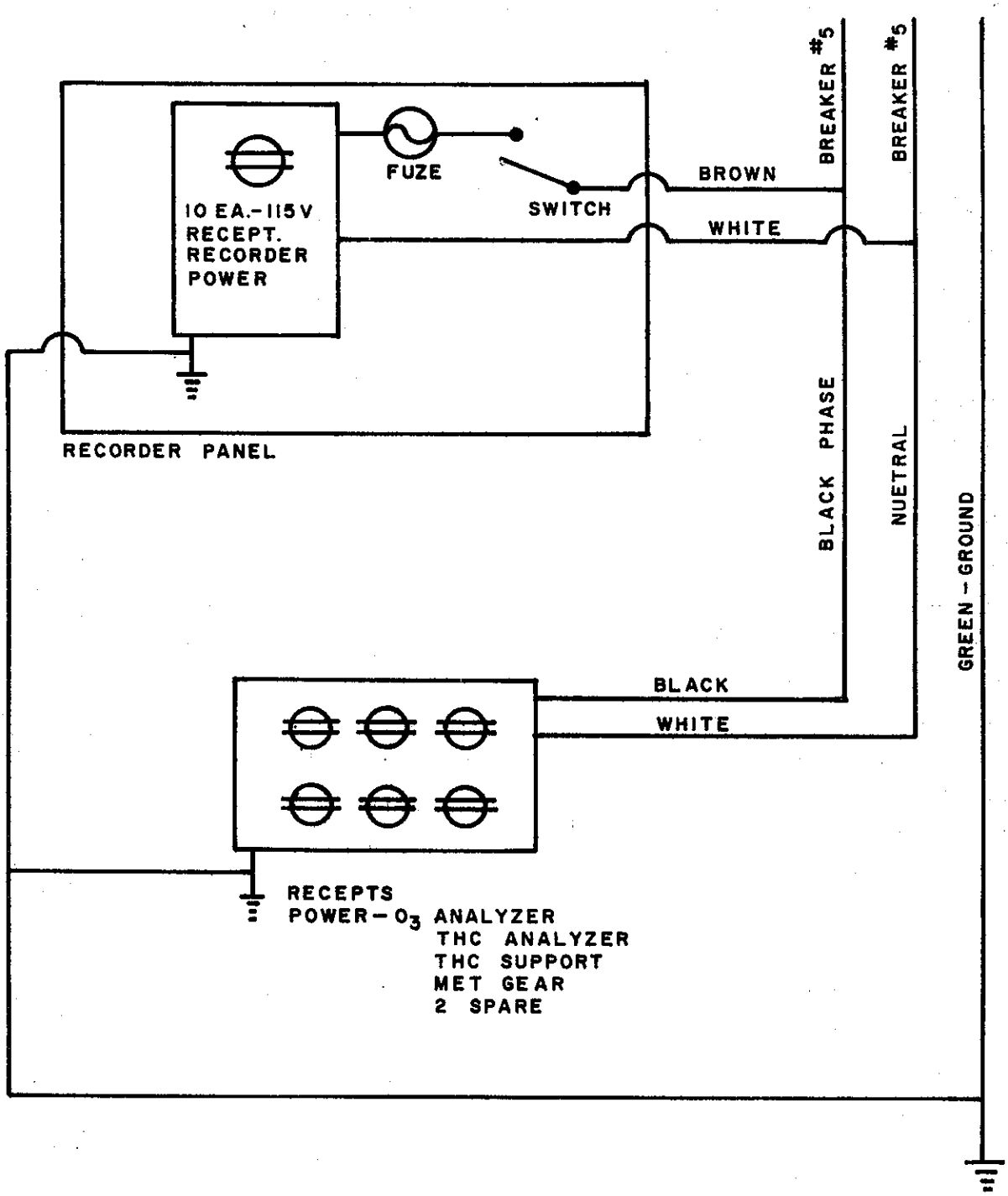
CO	3.0 AMP	AIR COND	12.0 AMP
O_3	1.0 AMP	VAC MAIN	3.5 AMP
NOX	5.8 AMP	HIVOL	4.1 AMP
THC	3.6 AMP		19.6 AMP
H_2GEN	1.0 AMP	PLUS	
RECDR'S	2.0 AMP	OUTLET	
MET	0.1 AMP	ONE LIGHT	
AIR COMP	3.5 AMP		
	20.0 AMP		
	BLACK		RED

Figure 24



60" RACK-WIRING-LEFT SIDE 115 VAC AIR COMPRESSOR, MAIN VAC,-NOX PUMPS, CO PUMP

Figure 25



70" RACK-WIRING-RIGHT SIDE 115 VAC

Figure 26

recorder power switch; all other instruments on this circuit have internal switching. Outlets for recorders mount on the rear of the recorder panel. Outlets for the rack mounted instruments mount on the THC Analyzer Support Tray and on the floor inside the base of the instrument rack. See Figure 26.

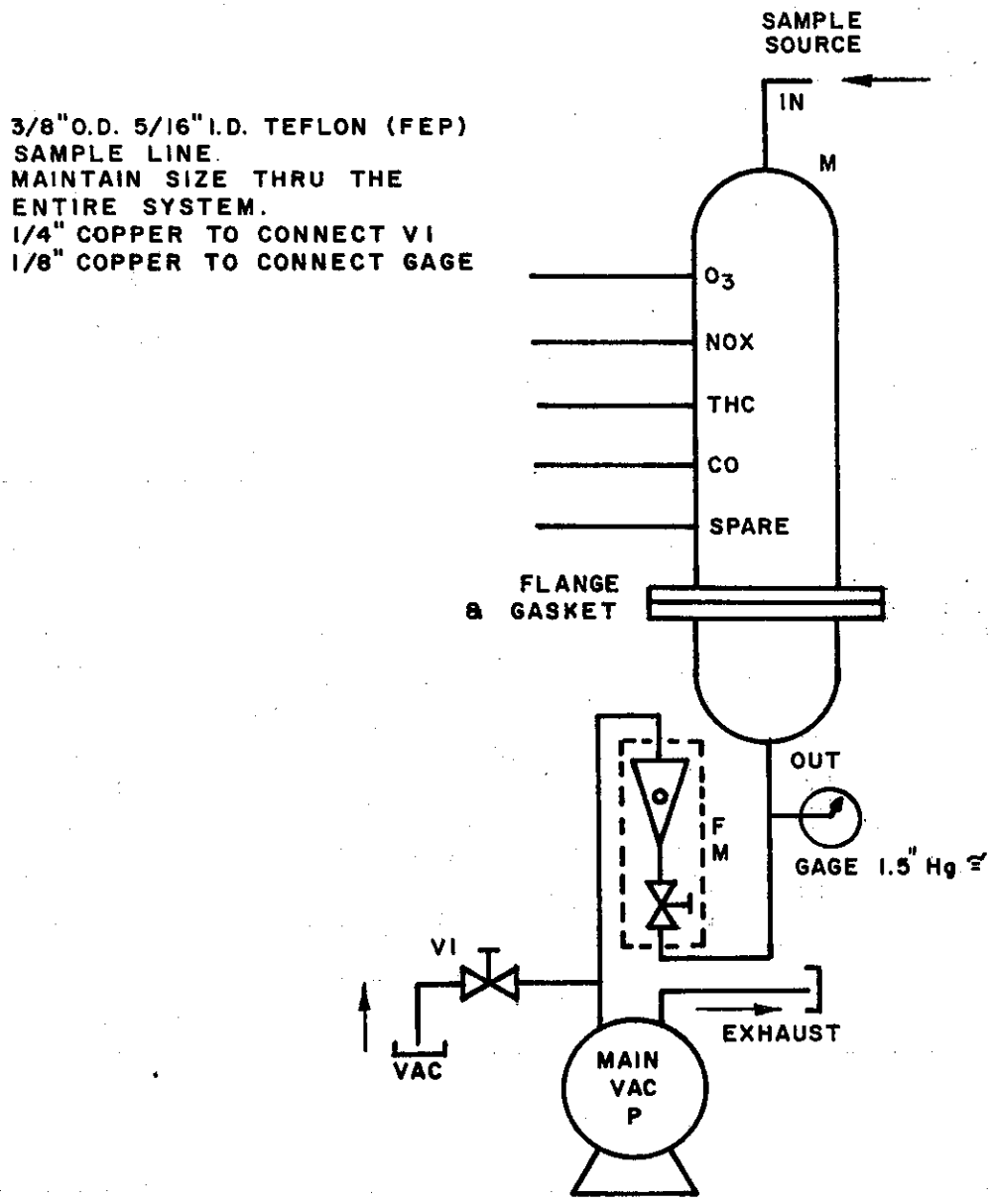
Power Left Side - Run conduit as per Figure 21 and locate outlets and junction boxes as noted. Vacuum pump (right side of vehicle) power is supplied by Breaker #2 and is switched from the main flow panel on the bulkhead (drivers side instrument rack). Power for the CO Analyzer and pump, air compressor, NO_x analyzer and pump, are supplied from Breaker #6. The air compressor and analyzer's pumps are switched from the main panel also. See figure 25.

Sample System

The air sample to be analyzed is drawn continuously through a sample probe from approximately one van height above the van and through the van wall to a stainless steel manifold. Here one sample line per analyzer is drawn off by individual analyzer pumps. The main continuous flow is maintained by a vacuum pump mounted under the van floor on the left side in front of the rear wheel well and exhausted below the vehicle. All controls and the pump switch are mounted on a panel in the left instrument rack.

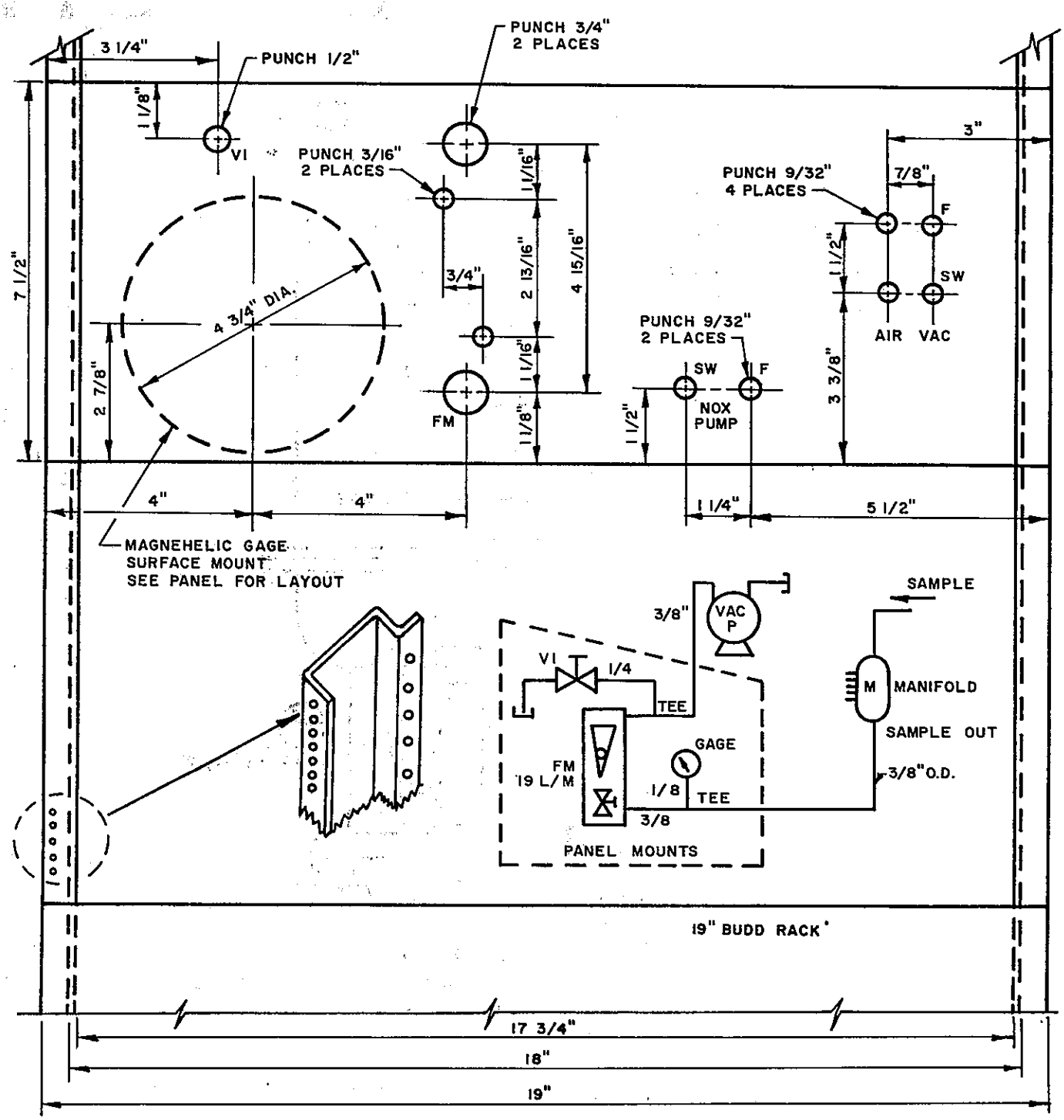
Sample probe with pole assembly - Mounts on right side of van over the wheel well area with a bulkhead connector. Main manifold with fittings - mounts on right side of van, wheel well area behind recorders.

Main vacuum pump - power piped to right wheel well for switch and fuse on main flow panel.



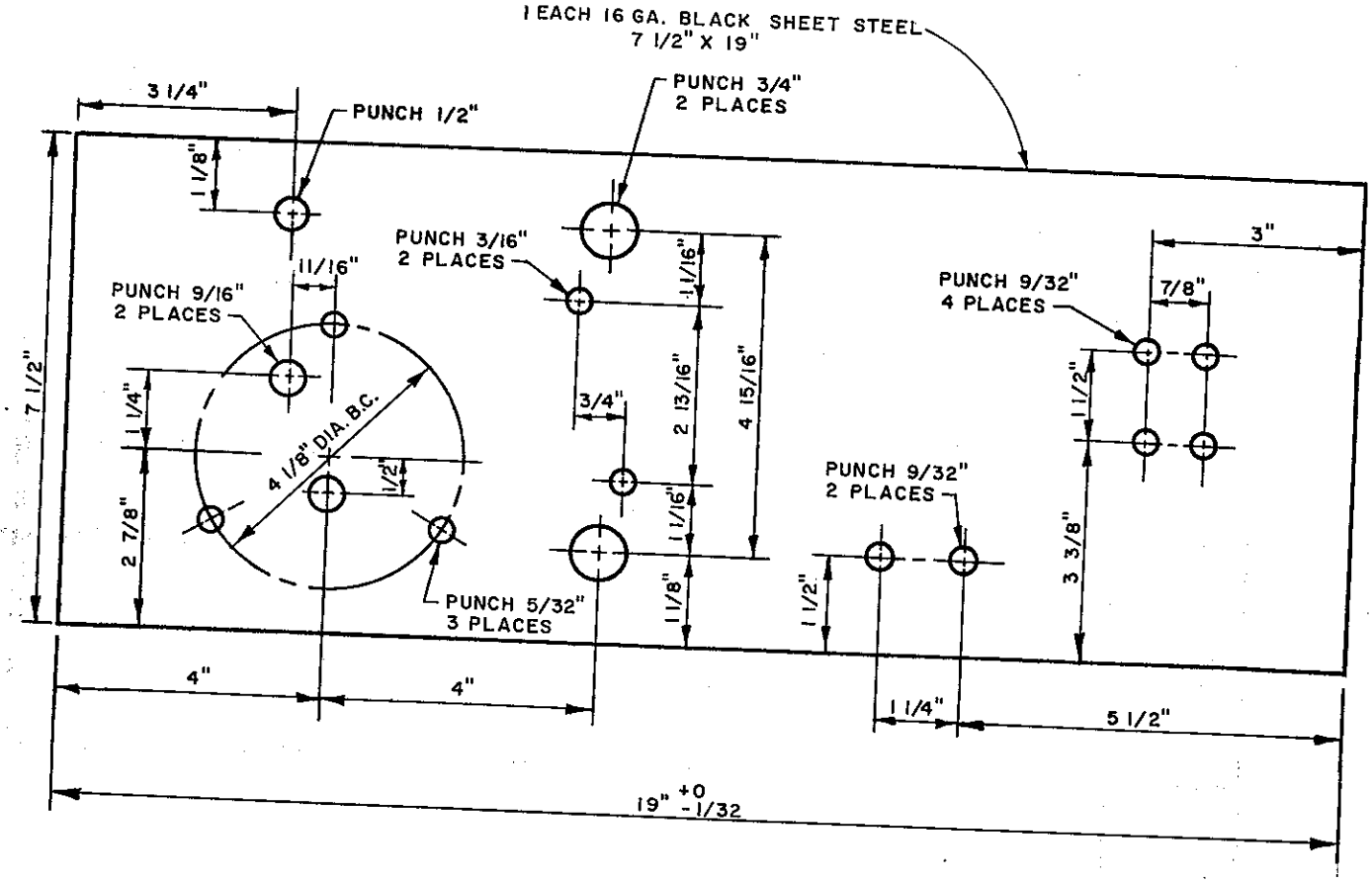
MAIN SCAVENGING VACUUM

Figure 27



MAIN FLOW PANEL

Figure 28



MAIN FLOW PANEL

Figure 29

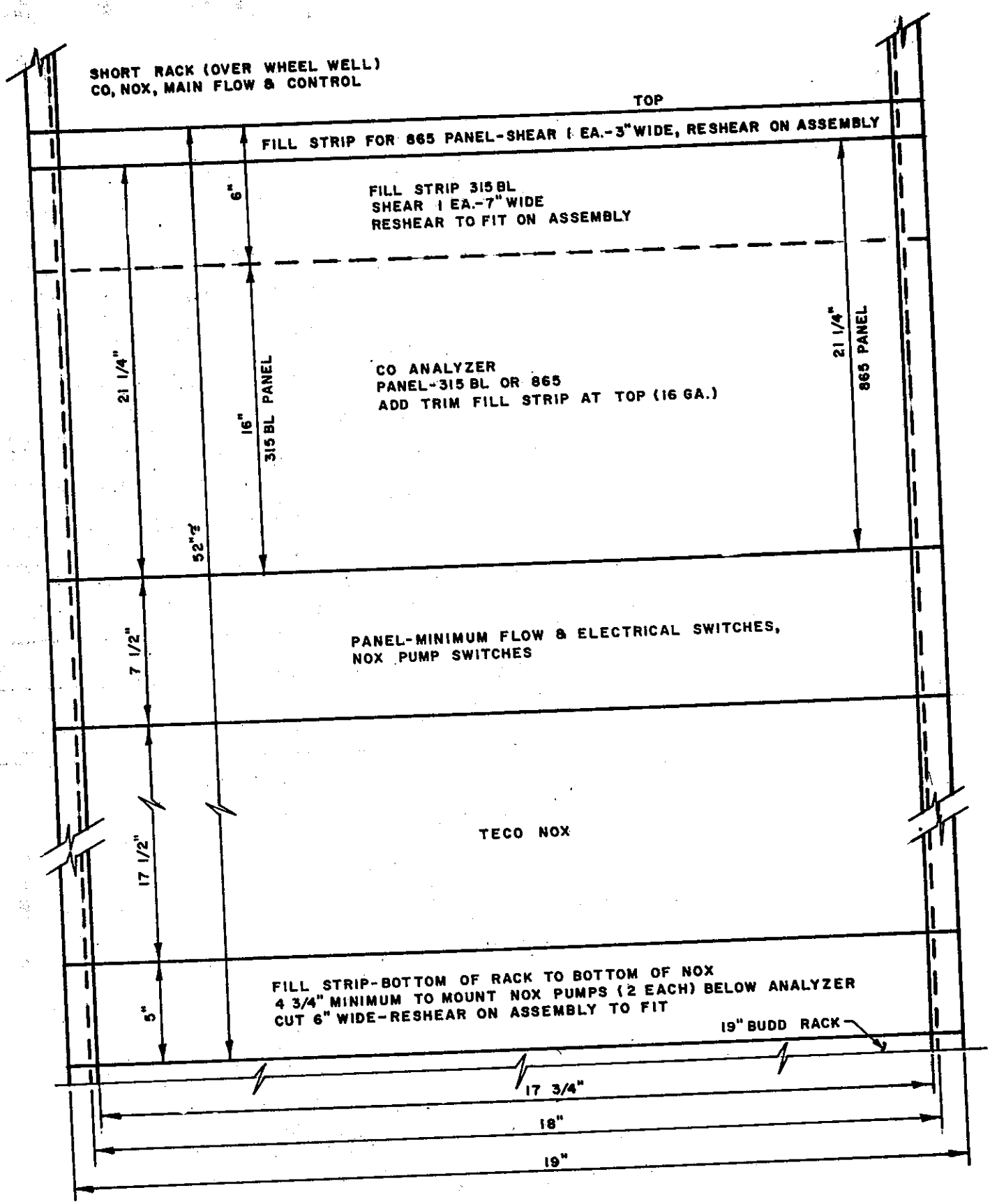
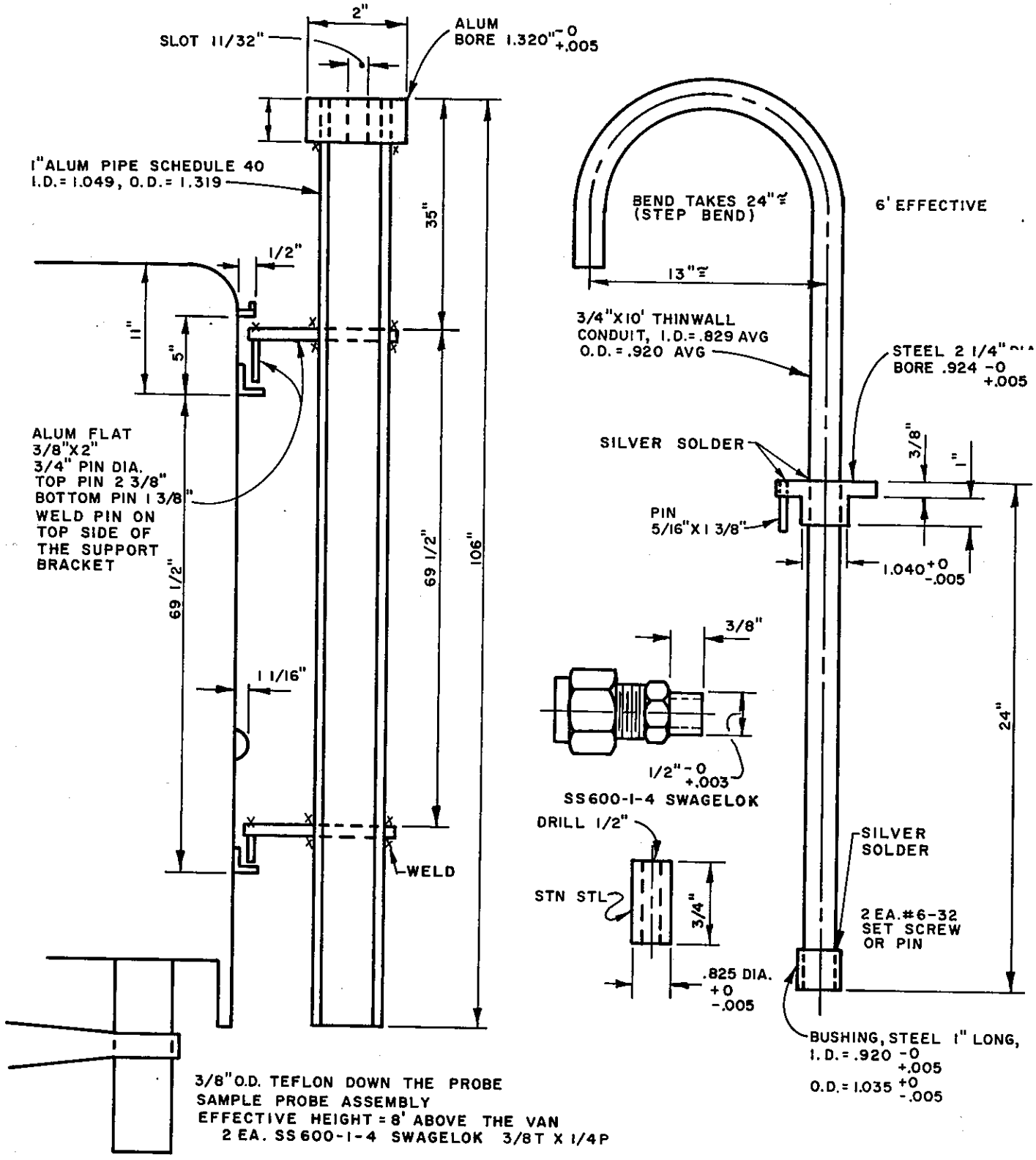


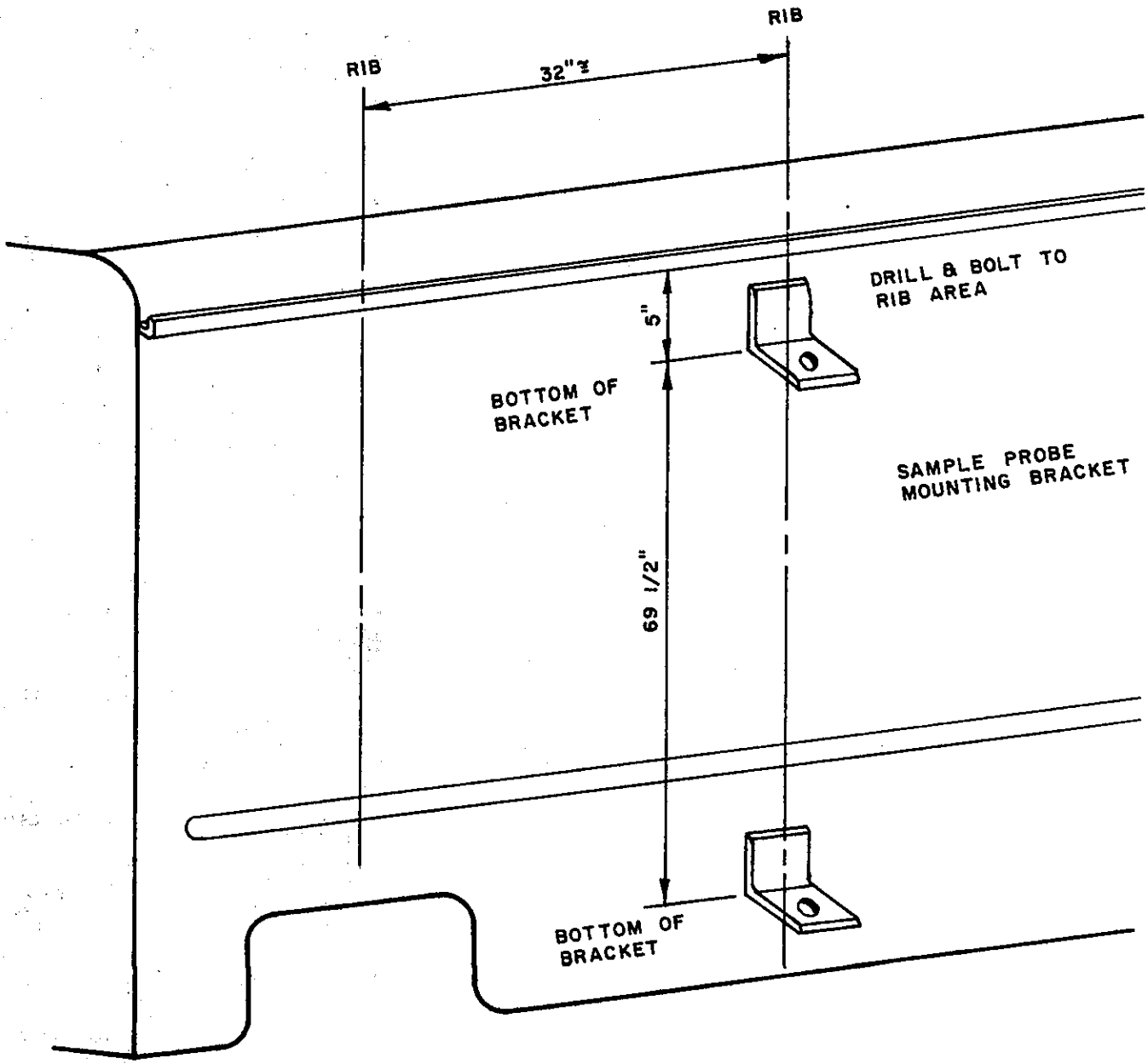
Figure 30



SAMPLE PROBE ASSEMBLY

1 EA. REQ'D.

Figure 31



VAN – RIGHT SIDE

MOUNT LOCATION FOR THE SAMPLE PROBE

Figure 32

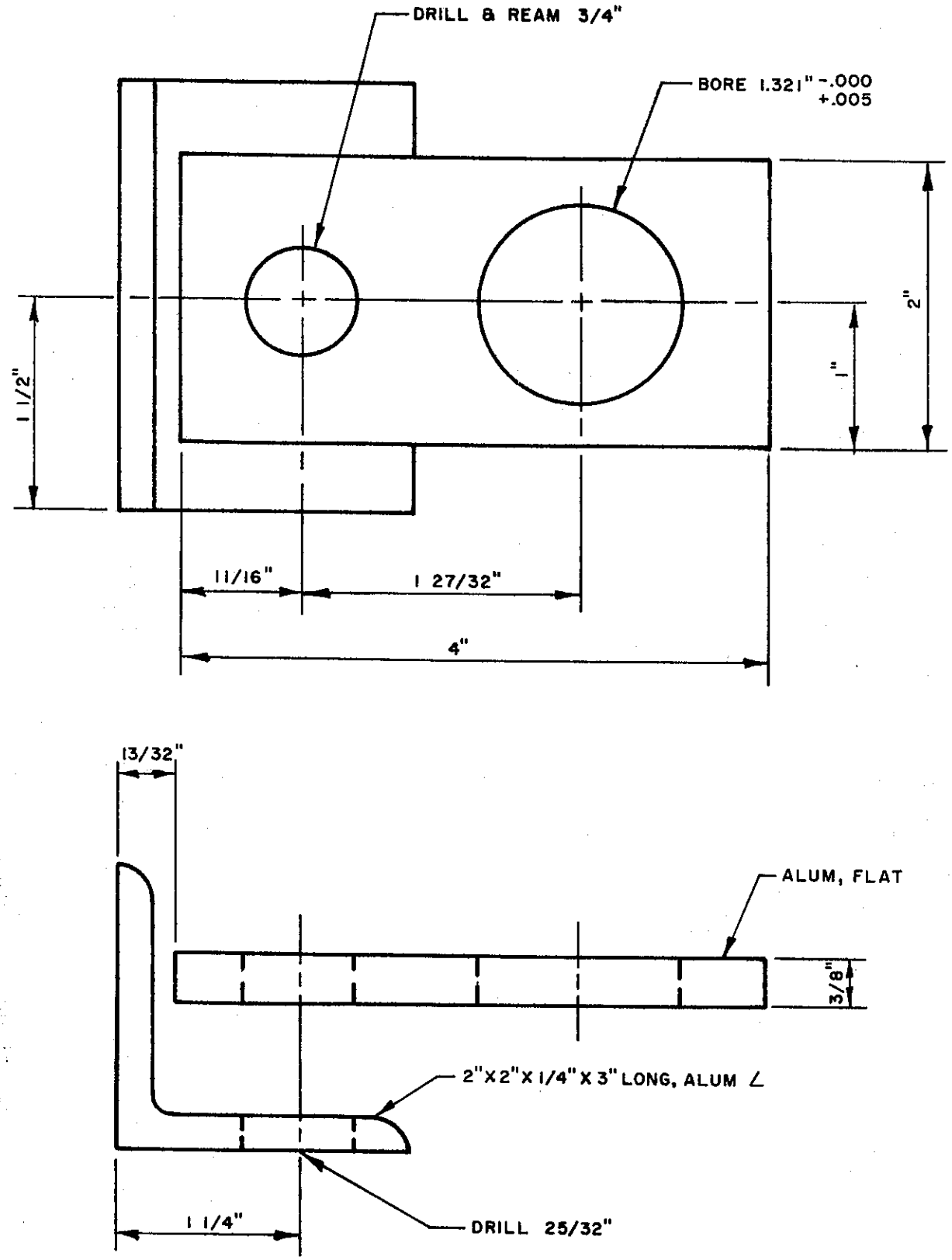


Figure 33

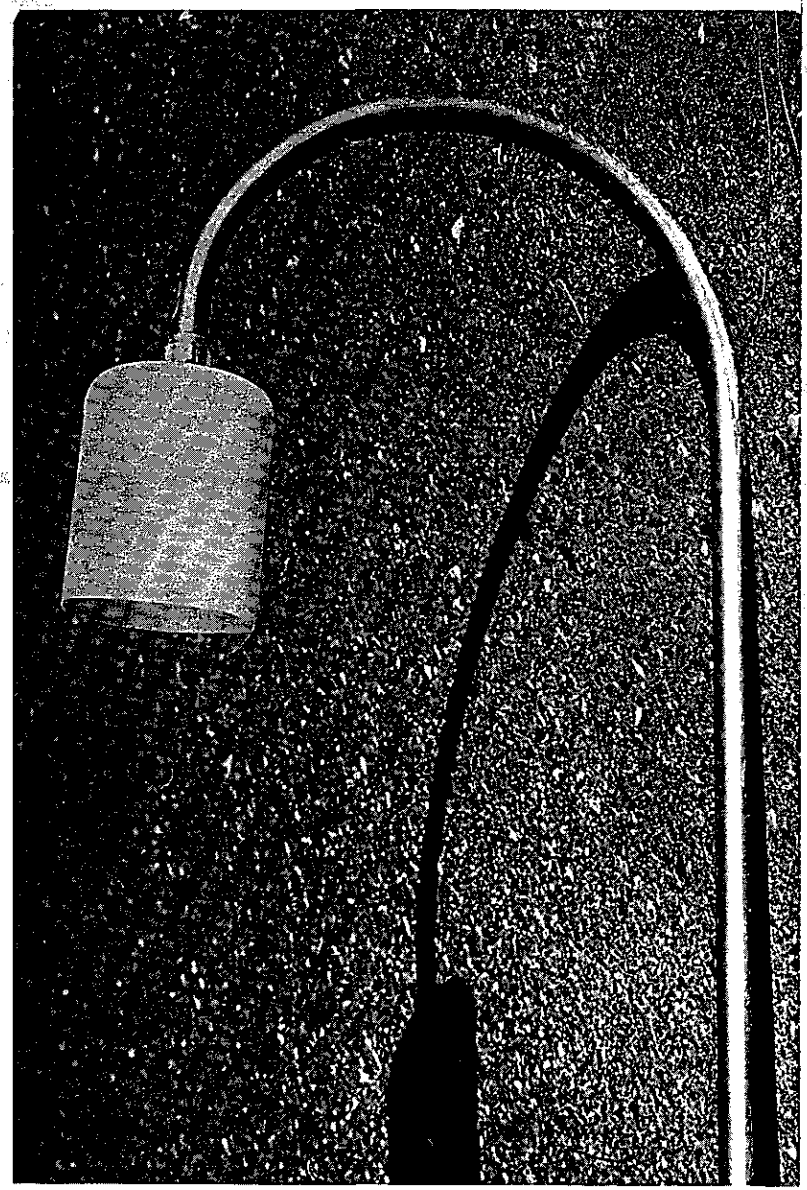


Fig. 34 Rain Shield-Sample Mast

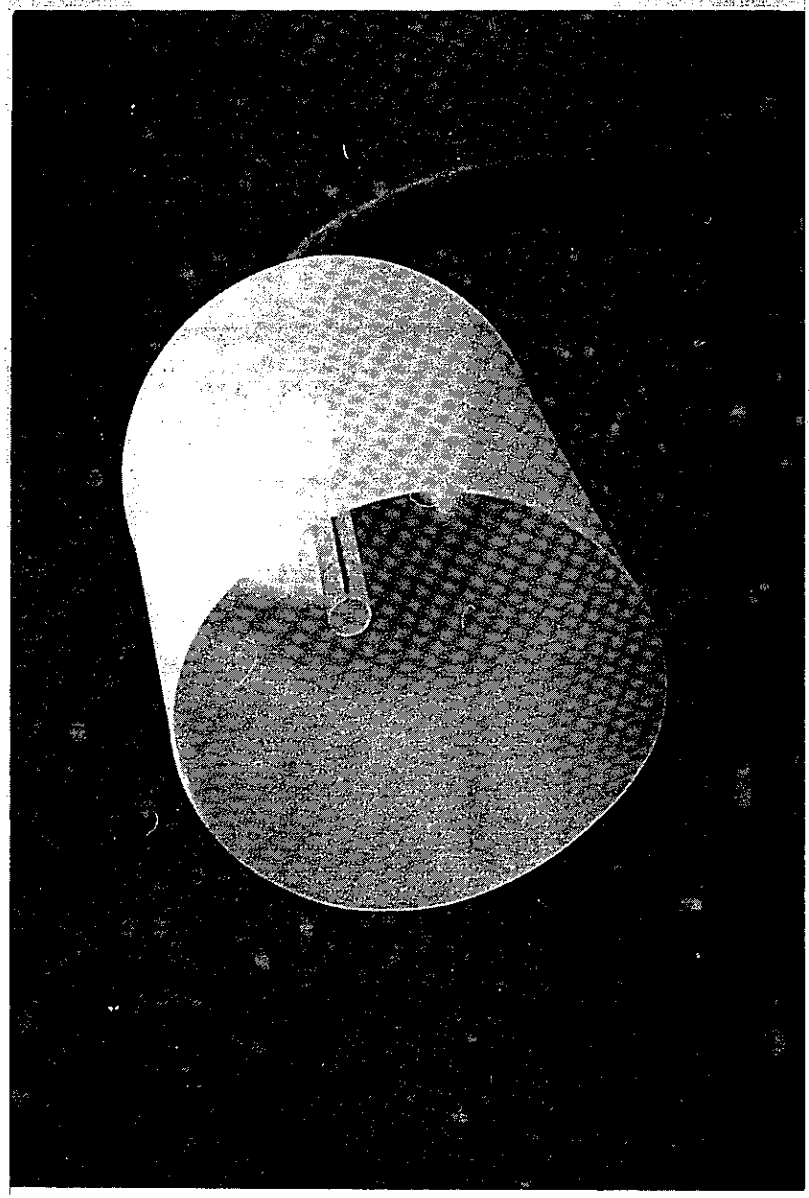
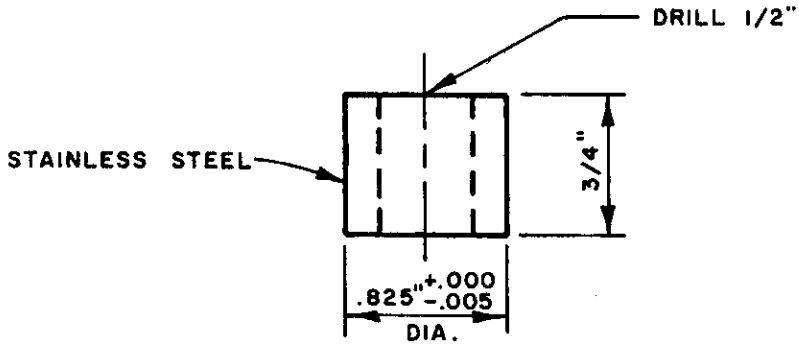


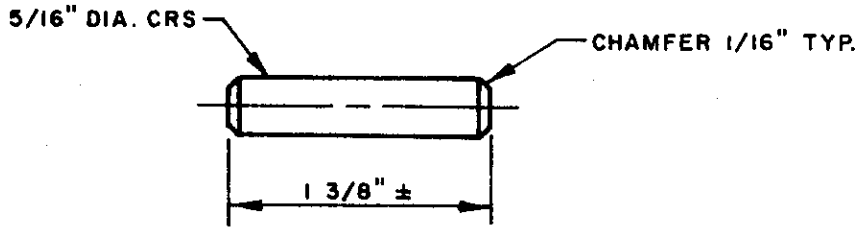
Fig. 35 Sample Tube-inside Rain Shield



SAMPLE PROBE SWAGELOK BUSHING

1 EA. REQD.

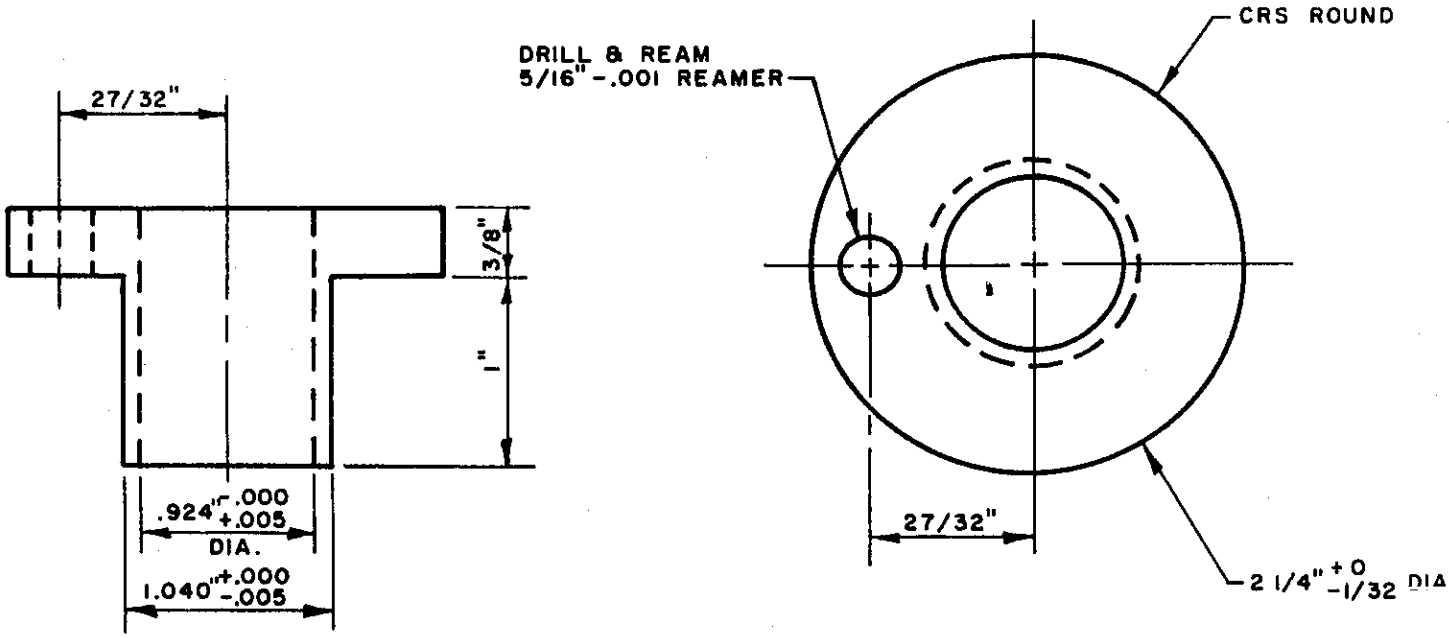
Figure 34



LOCKPINS

1 EA. REQD.

Figure 35



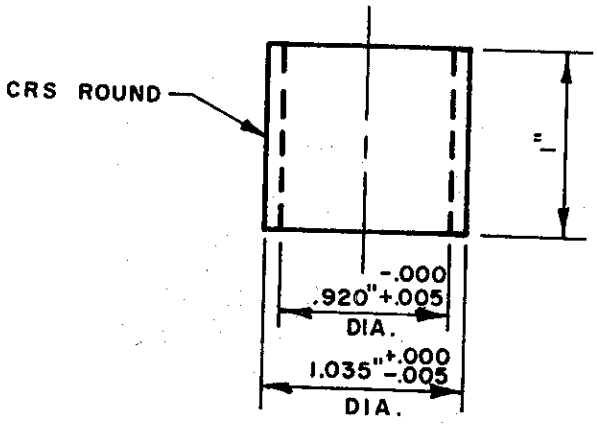
SIDE VIEW

SAMPLE PROBE STOP GUIDE

1 EA. REQD.

Figure 36

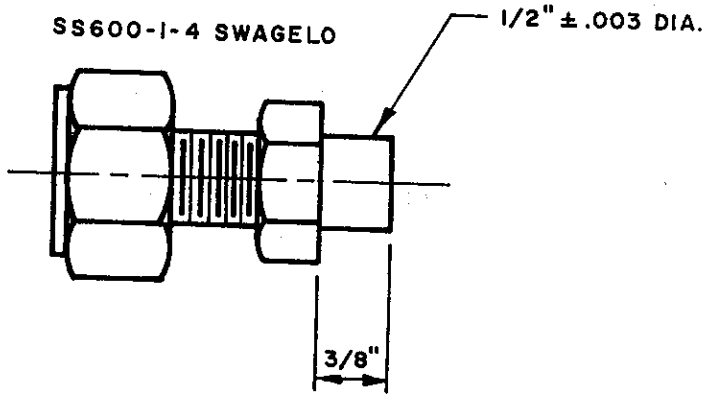
Fig. 37 Sample Tube Connector inside Sample Mast



SAMPLE PROBE GUIDE BUSHING

1 EA. REQ'D.

Figure 37



SILVER SOLDER TO SAMPLE PROBE SWAGELOK BUSHING. (2 FITTINGS PER BUSHING) LINE REAM 5/16" AFTER ASSEMBLY.

SWAGELOK STAINLESS STEEL FITTING

2 EA. REQ'D.

Figure 38

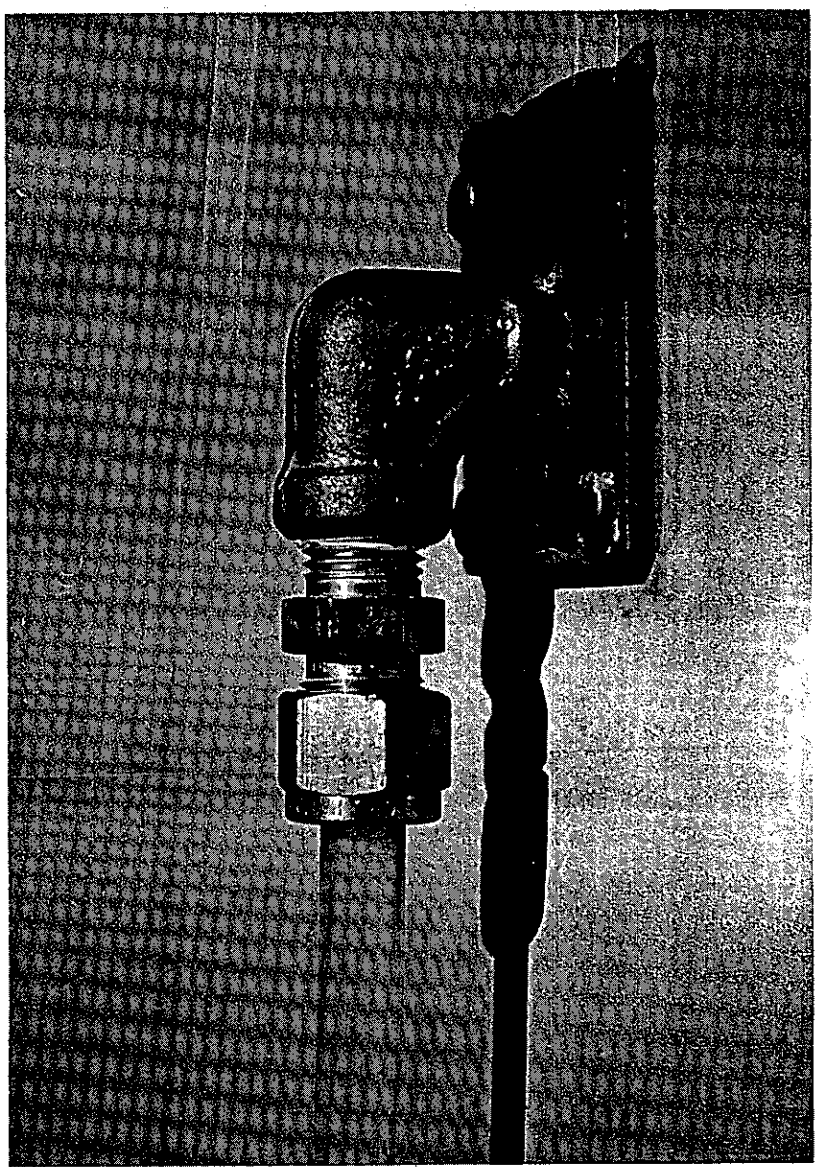
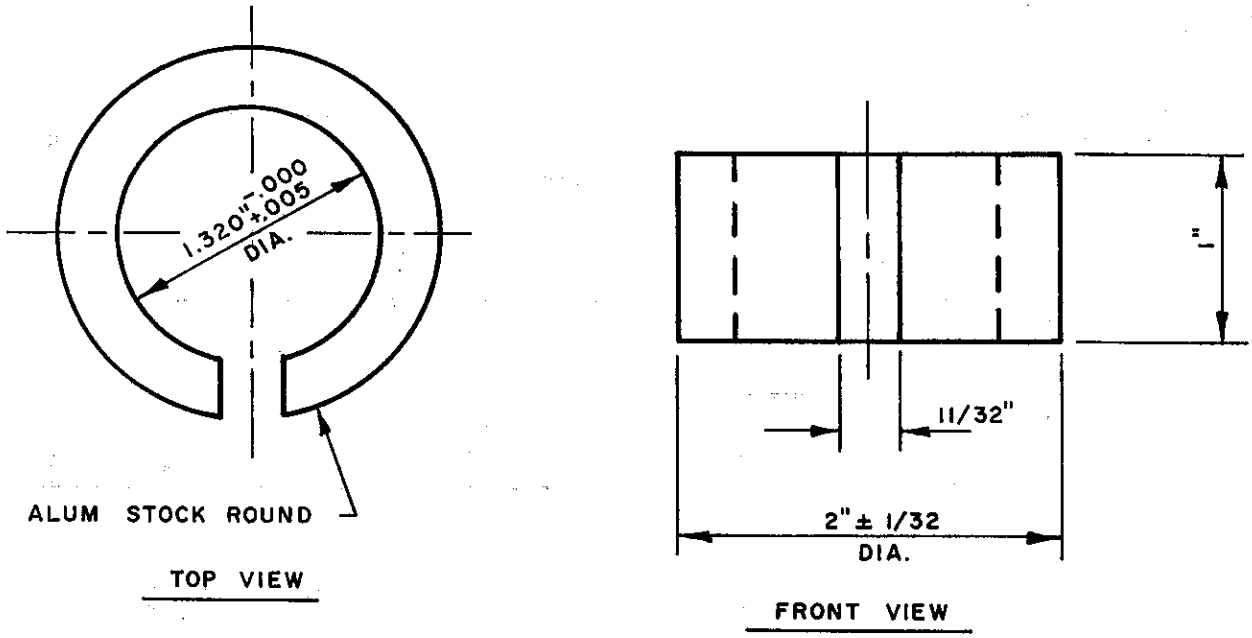


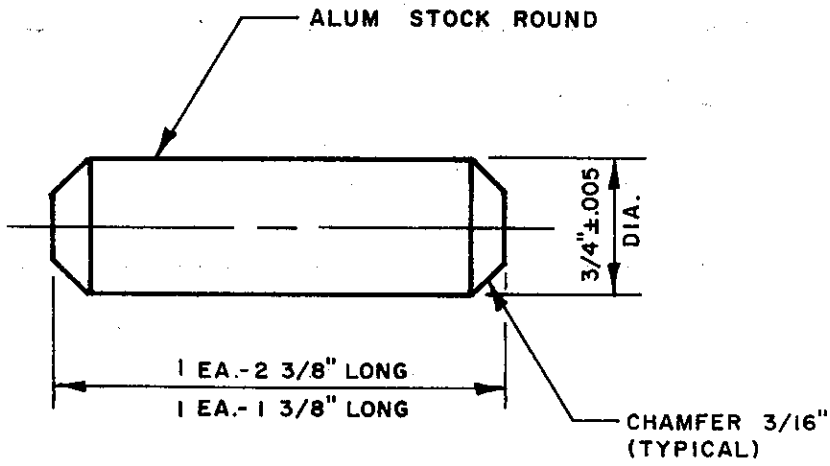
Fig. 39 Sample Tube Thru Van Wall-Outside



SAMPLE PROBE STOP

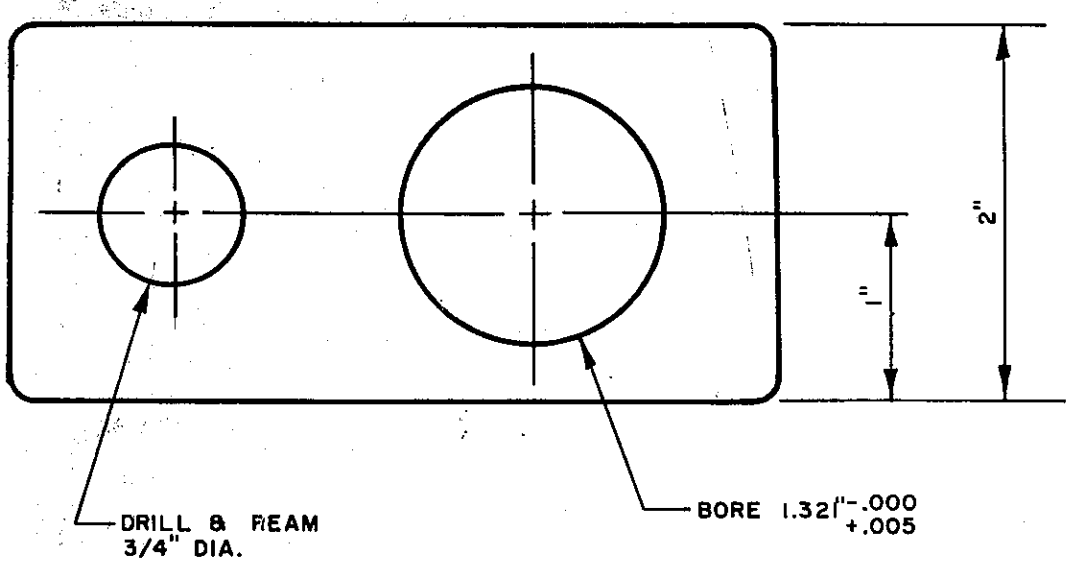
1 EA REQ'D.

Figure 39

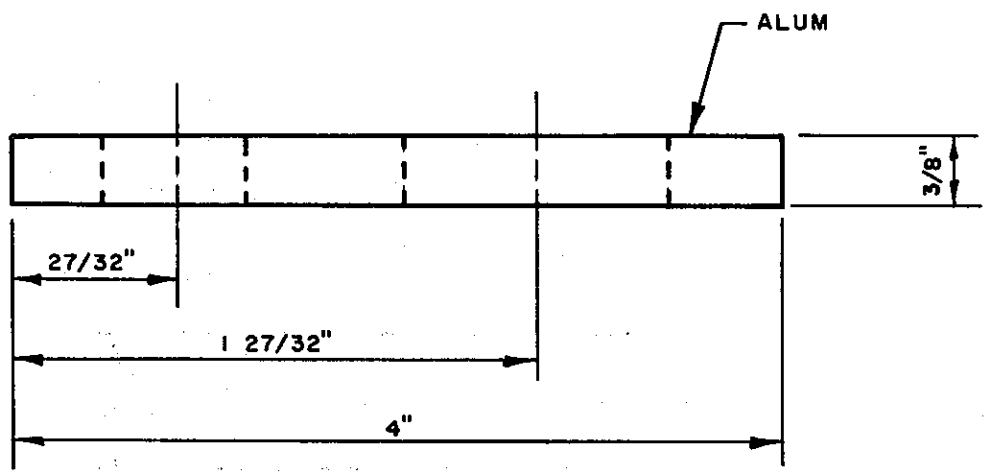


SAMPLE PROBE MOUNTING PINS

Figure 40



TOP VIEW

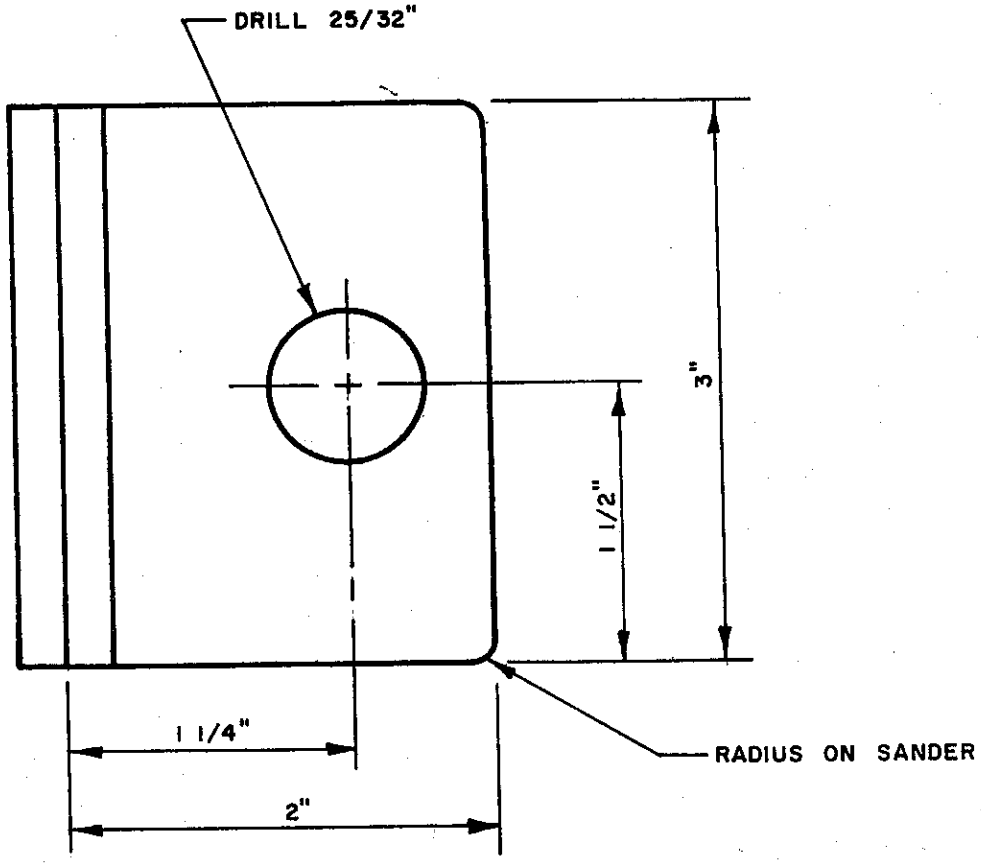


SIDE VIEW

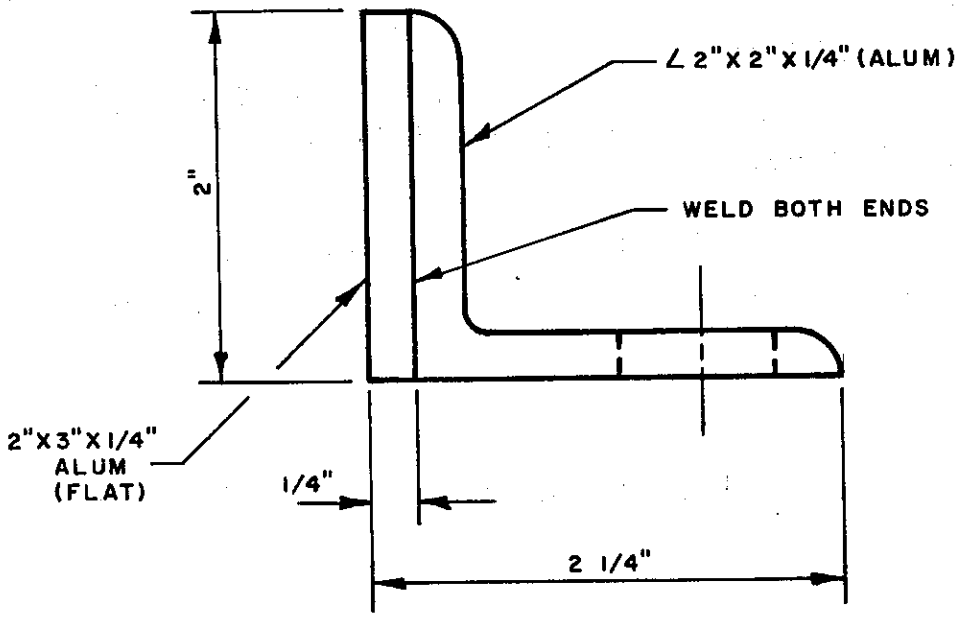
SAMPLE PROBE SUPPORT BRACKET

2 EA. REQ'D.

Figure 41



TOP VIEW



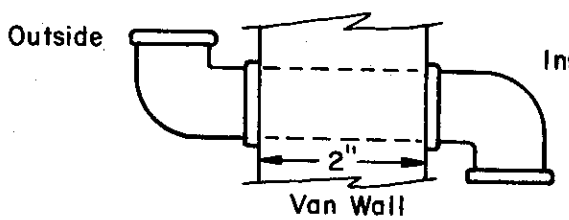
ELEVATION VIEW

SAMPLE PROBE MOUNTING BRACKET- 2 EA. REQ'D.

Figure 42

Parts

Sample probe and pole assembly with mounting.
Main manifold with fittings.
Main vacuum pump 284M-Gast oilless type.
#0211-103A-G8C, 115 volt 4.2A 1/6 hp.
3 each switch SPST (for NO_x pump air compressor vac pump)
3 each fuseholder panel mount (for above circuits)
2 each 1/4" NPT Brass pipe tee
2 each 1/4" NPT Brass close nipple
1 each B-200-1-4 Swagelok male connector 1/4Px1/8T
1 each B-200-1-2 " " " " " 1/8Px1/8T
4 each B-600-1-4 " " " " " 1/4Px3/8T
1 each B-400-1-4 " " " " " 1/4Px1/4T
2 each B-400-1-2 " " " " " 1/8Px1/4T
1 each (VI) B-1-RF2 Whitney Valve .172 1/8" FNPT
1 each FM Fisher Porter flowmeter #10A3135N w/needle valve 19000 cc/M air, % scale.
1 each Model 2040 Dwyer magnehelic pressure gage for 20" H_2O vacuum.



2 each 1/4" Stainless Steel El's w/ Nipple – 3/8" Swage

Sample inlet - 1/8" x 2" x 2" stainless welded to one 1/4" pipe ell for mounting to exterior of van. Weather seal with silicon sealer.

Parts

1 each 1/4" NPT stainless steel ell with mounting plate welded to the ell.

1 each 1/4" NPT stainless steel ell.

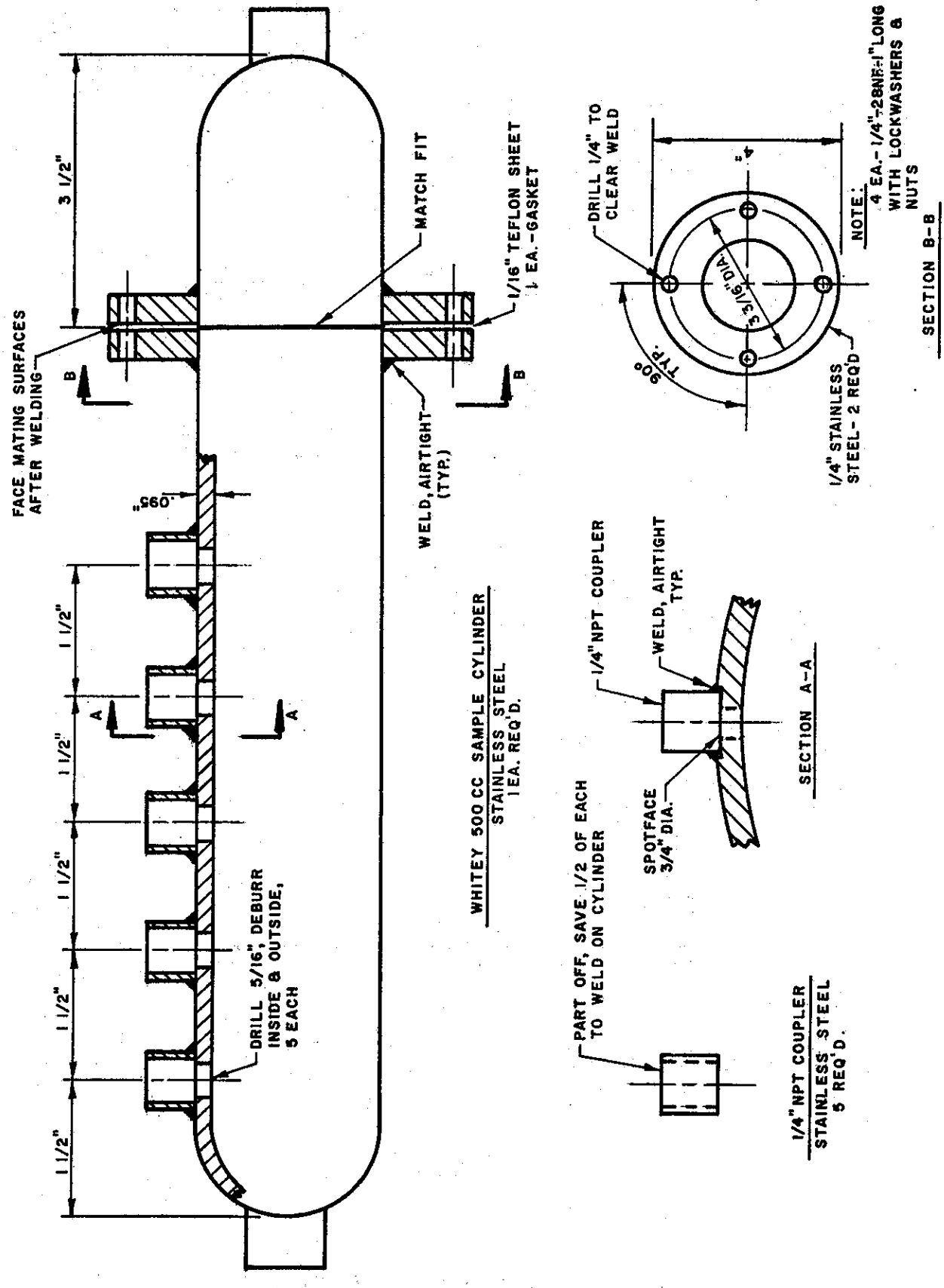
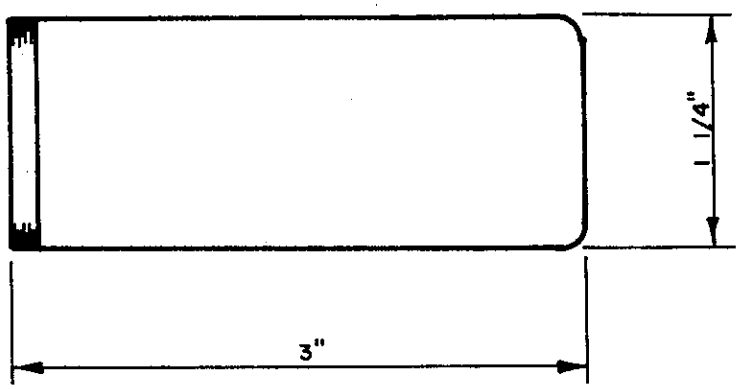
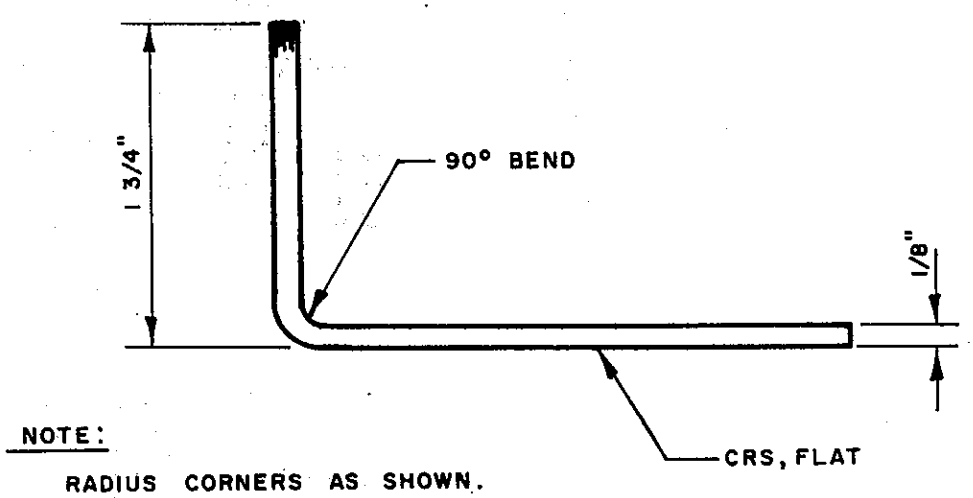


Figure 43



TOP VIEW



NOTE:

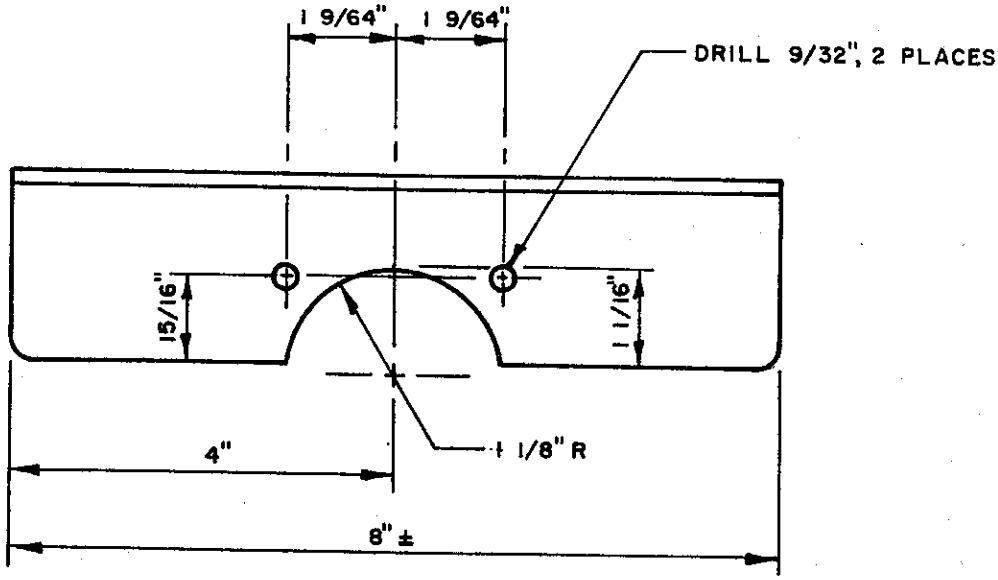
RADIUS CORNERS AS SHOWN.

ELEVATION VIEW

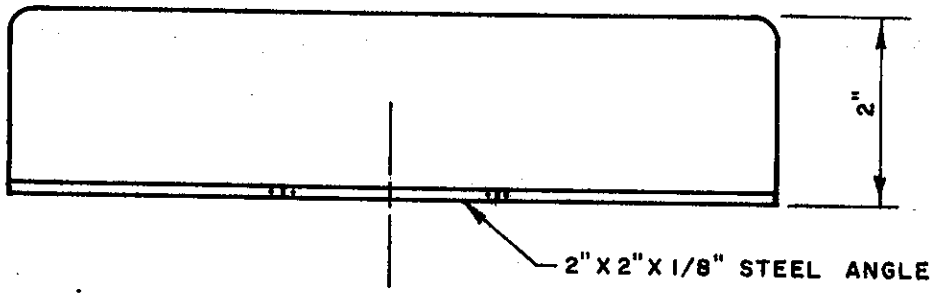
MAIN MANIFOLD SUPPORT BRACKET

1 EA. REQD.

Figure 44



TOP VIEW



NOTE:

RADIUS CORNERS AS SHOWN.

ELEVATION VIEW

MAIN MANIFOLD MOUNTING BRACKET

1 EA. REQD.

Figure 45

1 each 1/4" NPT stainless steel nipple ream 3/8" I.D.

2 each SS-600-1-4 stainless Swagelok male connector 1/4Px3/8T.

1 each SS-600-P stainless Swagelok plug 3/8T.

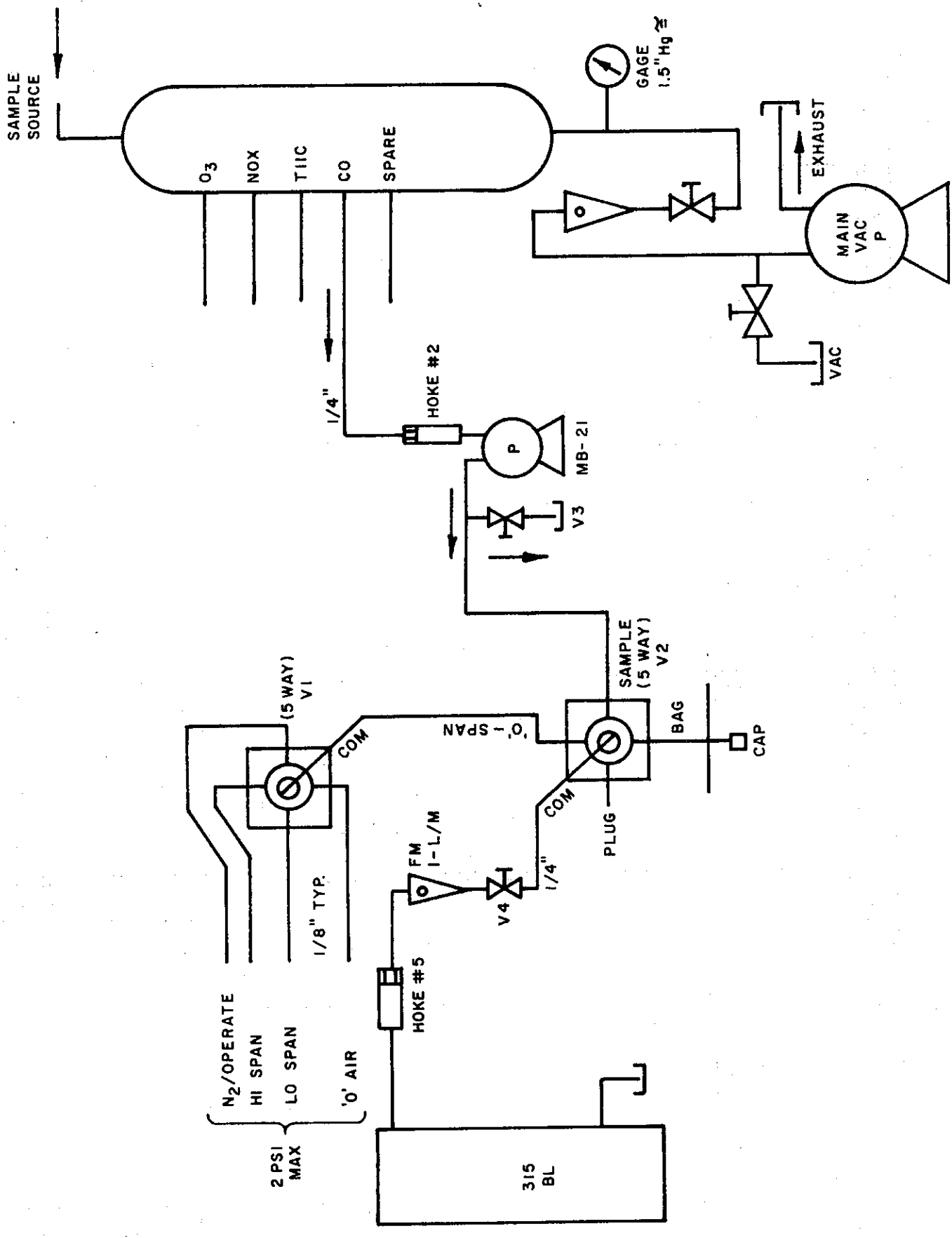
Carbon Monoxide Analyzer System

The van was designed to use two models of carbon monoxide analyzers, the older Beckman 315BL and the latest 865 model. Both are nondispersive infrared absorption devices and differ mainly in sample cell length, 40" vs 15" respectively. In addition, the 865 has a dynamic reference cell (constant flow of scrubbed air vs sealed dry nitrogen) and a zero air scrubber. They are different in mounting as the cell chamber is separate in the model 315BL and must be mounted aft of the left instrument rack and protected from shock by isolator mounts. (See Section on vibration protection.) The electronic head is panel mounted in the top of the left instrument rack for the 315BL. The complete analyzer is mounted in the same area for the model 865.

CO Analyzer Model 315BL Beckman

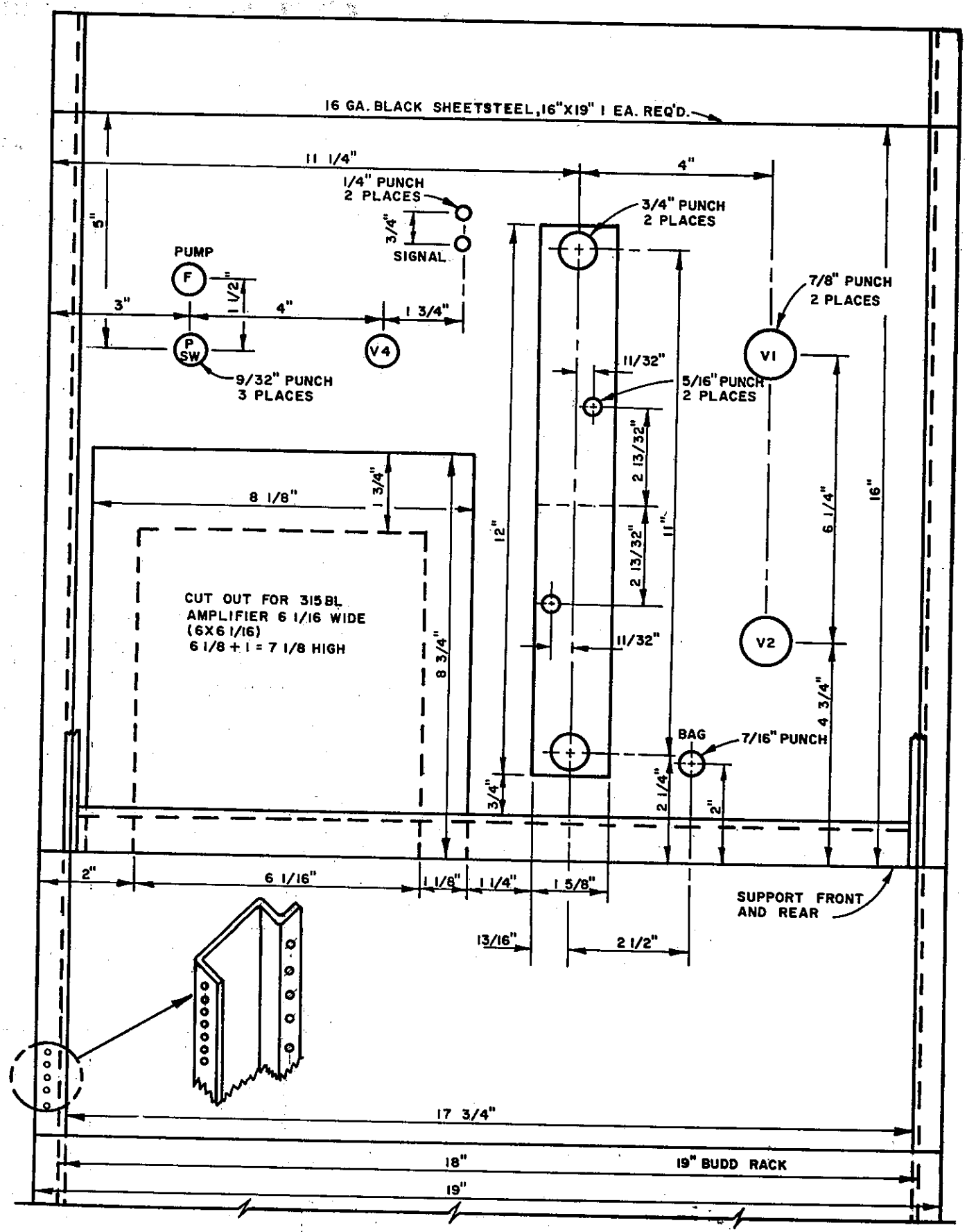
Parts List - See Figures 46, 47, and 48 for assembly.

2 each (V1 & V2) B-43ZF-2 Whitey 5 way valve 1/8" FNPT
1 each 1/8" NPT Brass pipe plug
6 each B-200-1-2 Swagelok male connector 1/8Px1/8T
4 each B-200-1-4 " " " 1/4Px1/8T
4 each Victor Pressure Regulators VTS400B, 2 stage stainless steel diaphragms. Northern Calif. Moore Bros. 69th & Q Streets, Sacramento, CA Phone 916-452-6431



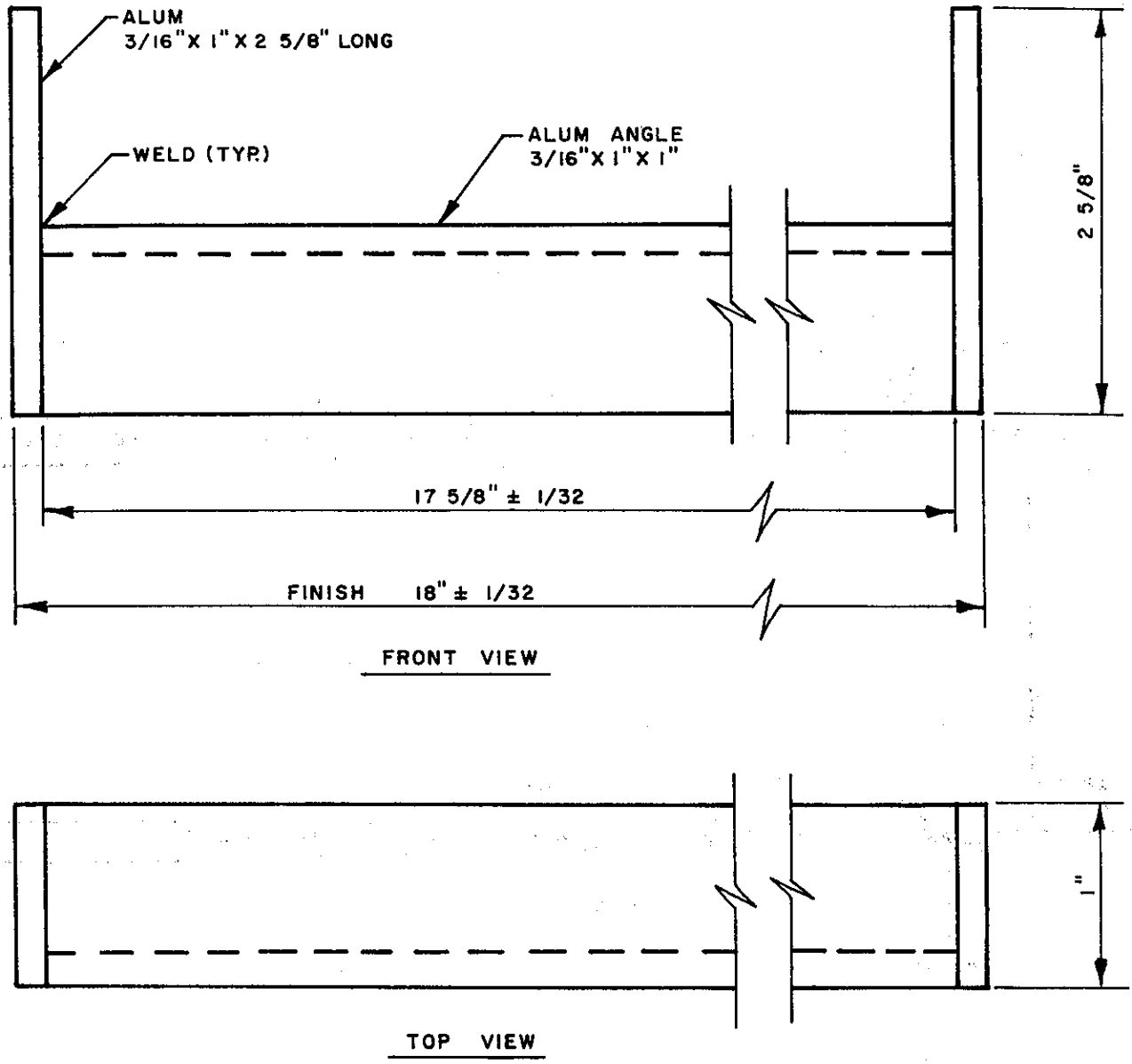
CO ANALYZER - BECKMAN 315 BL

Figure 46



315 BL BECKMAN CO ANALYZER
AMPLIFIER & VALVE PANEL

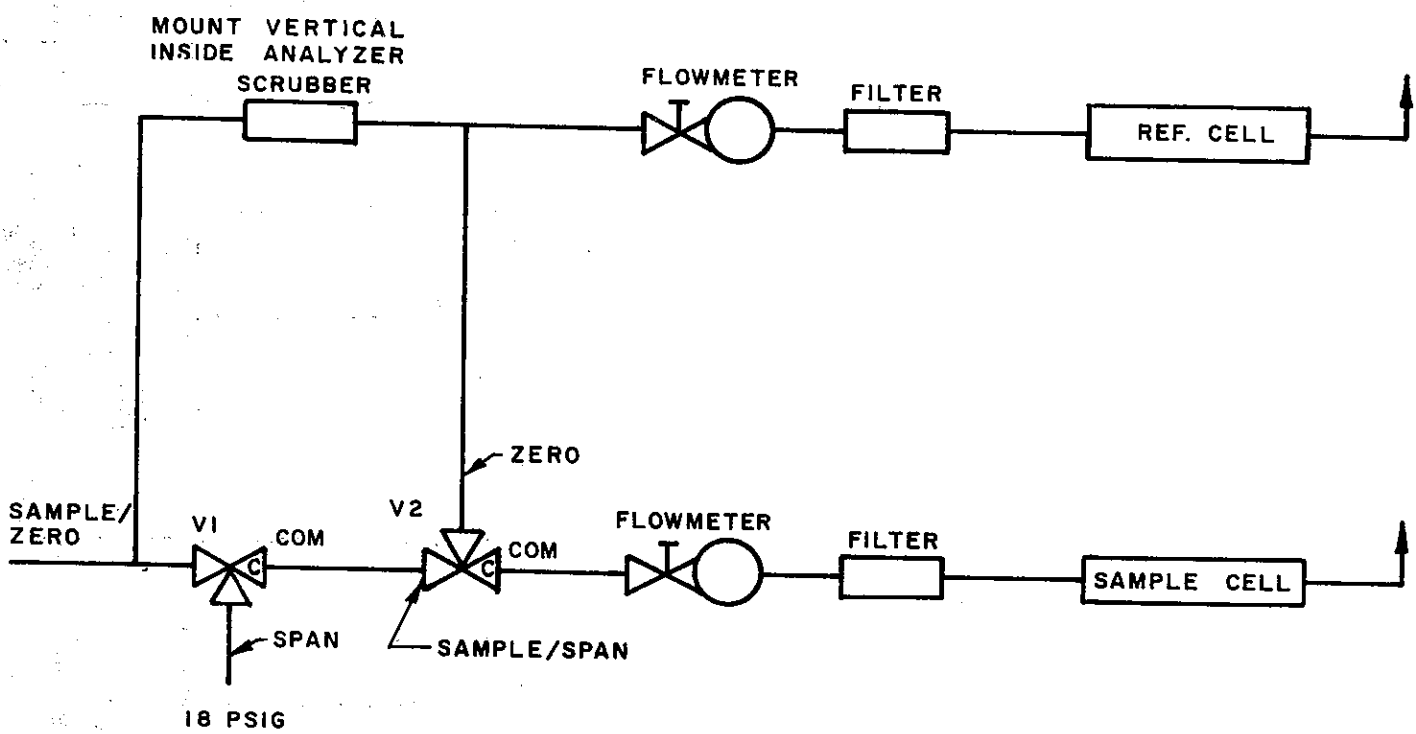
Figure 47



MOUNTING BRACKETS
FRONT & REAR CO ANALYZER

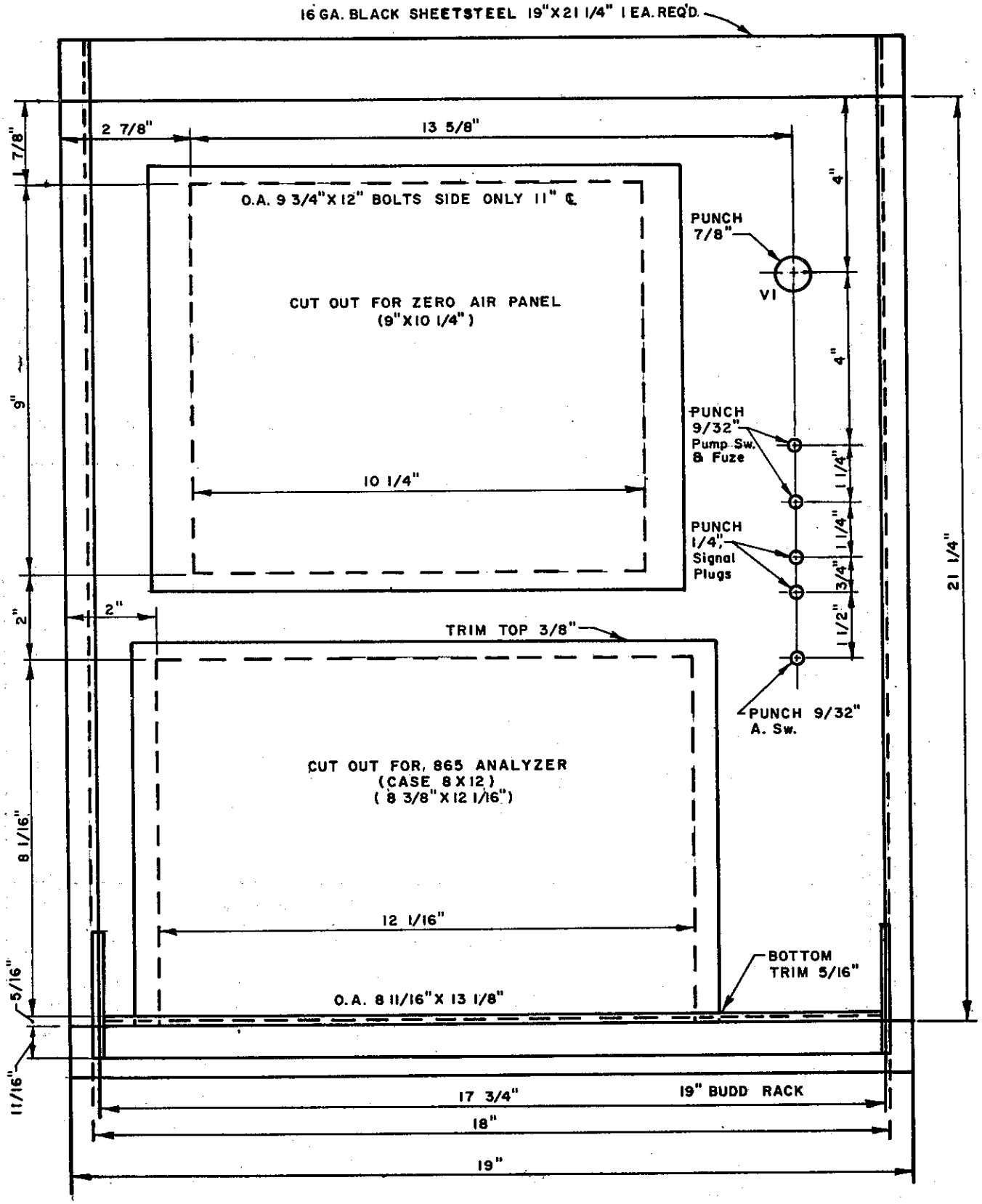
2 EA. REQ'D. { 1-FRONT
1-REAR

Figure 48



SAMPLE SELECTOR PANEL FOR
MODEL 865 CO-AIR MONITORING
(FLOWING REFERENCE 'O' PANEL)
MFG BY BECKMAN INSTRUMENTS INC.

Figure 49



865 BECKMAN CO ANALYZER

ANALYZER & ZERO AIR & VALVE PANAL

Figure 50

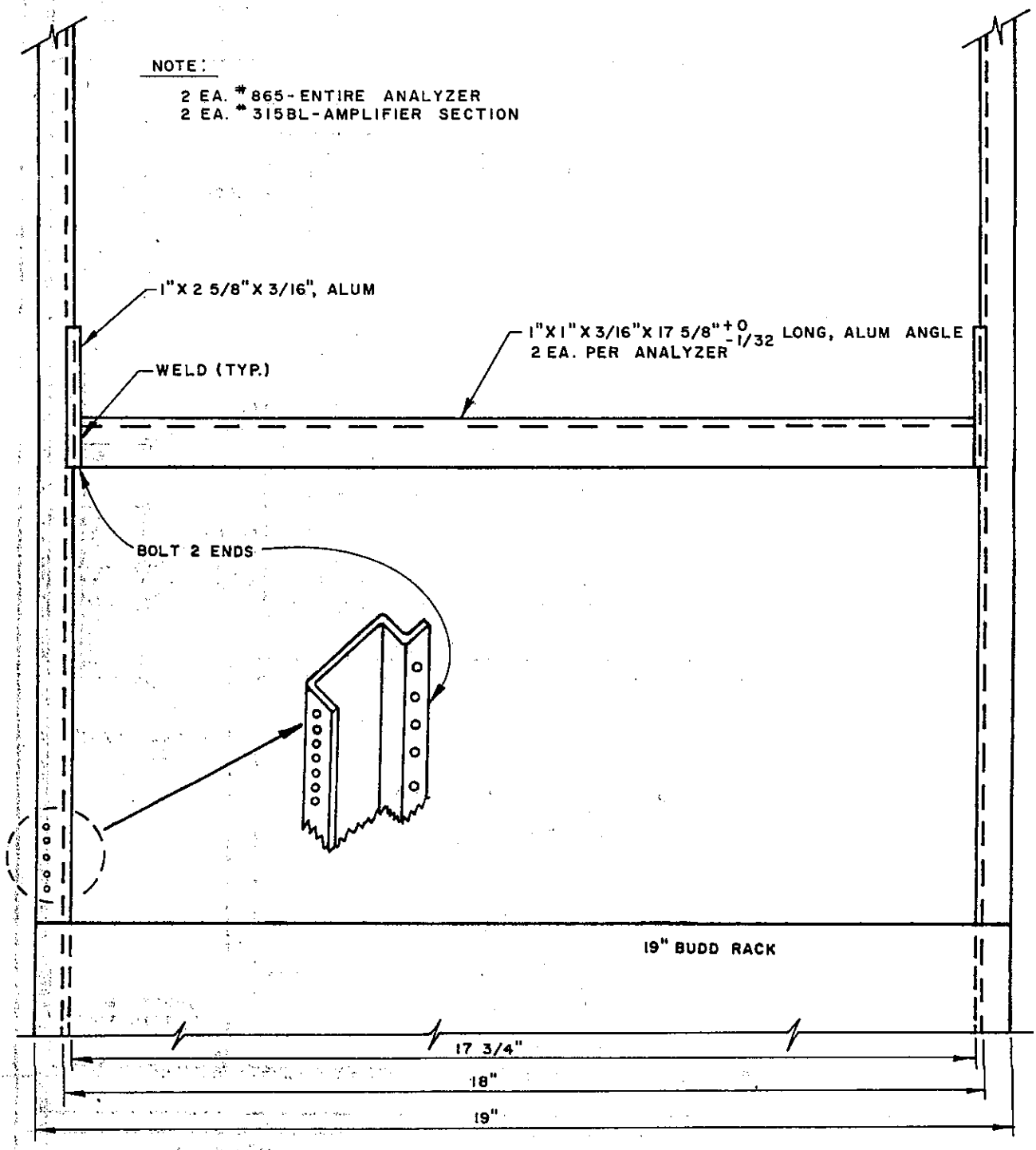
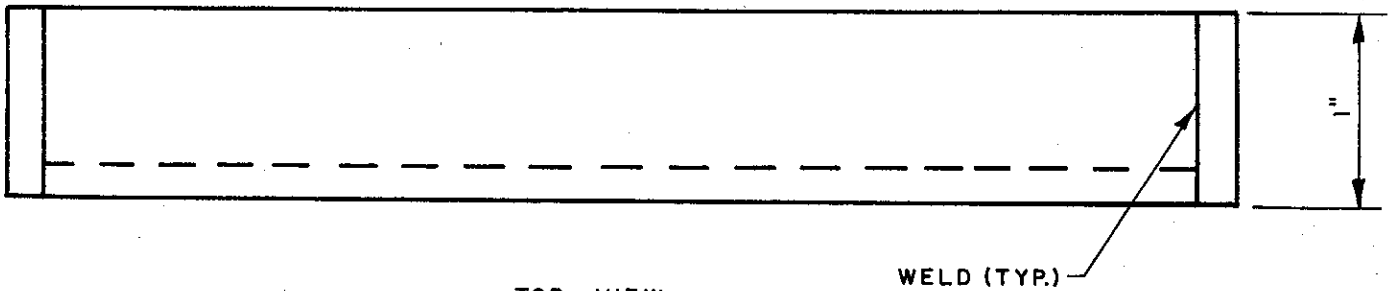
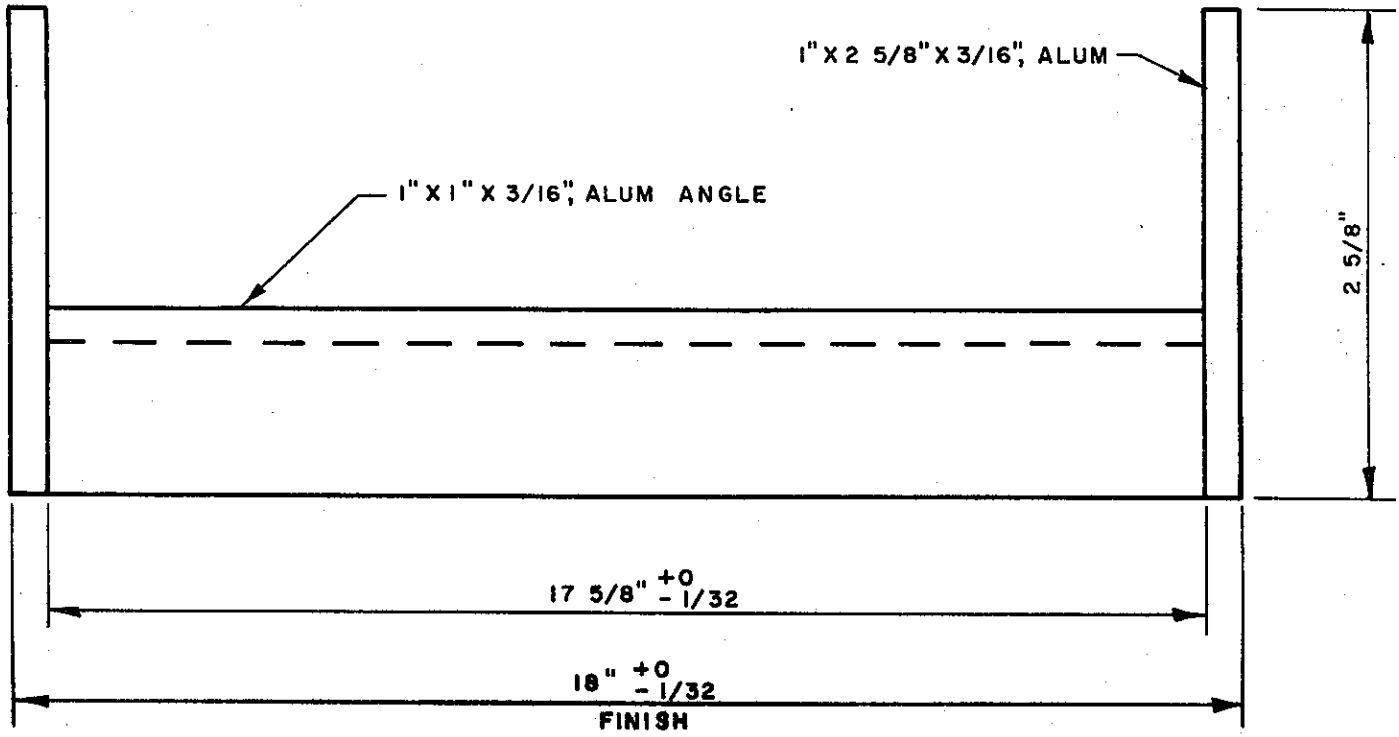


Figure 51



TOP VIEW



FRONT VIEW

(MOUNTING BRACKET)
2 EA. REQ'D.

FRONT & REAR CO ANALYZER

Figure 52

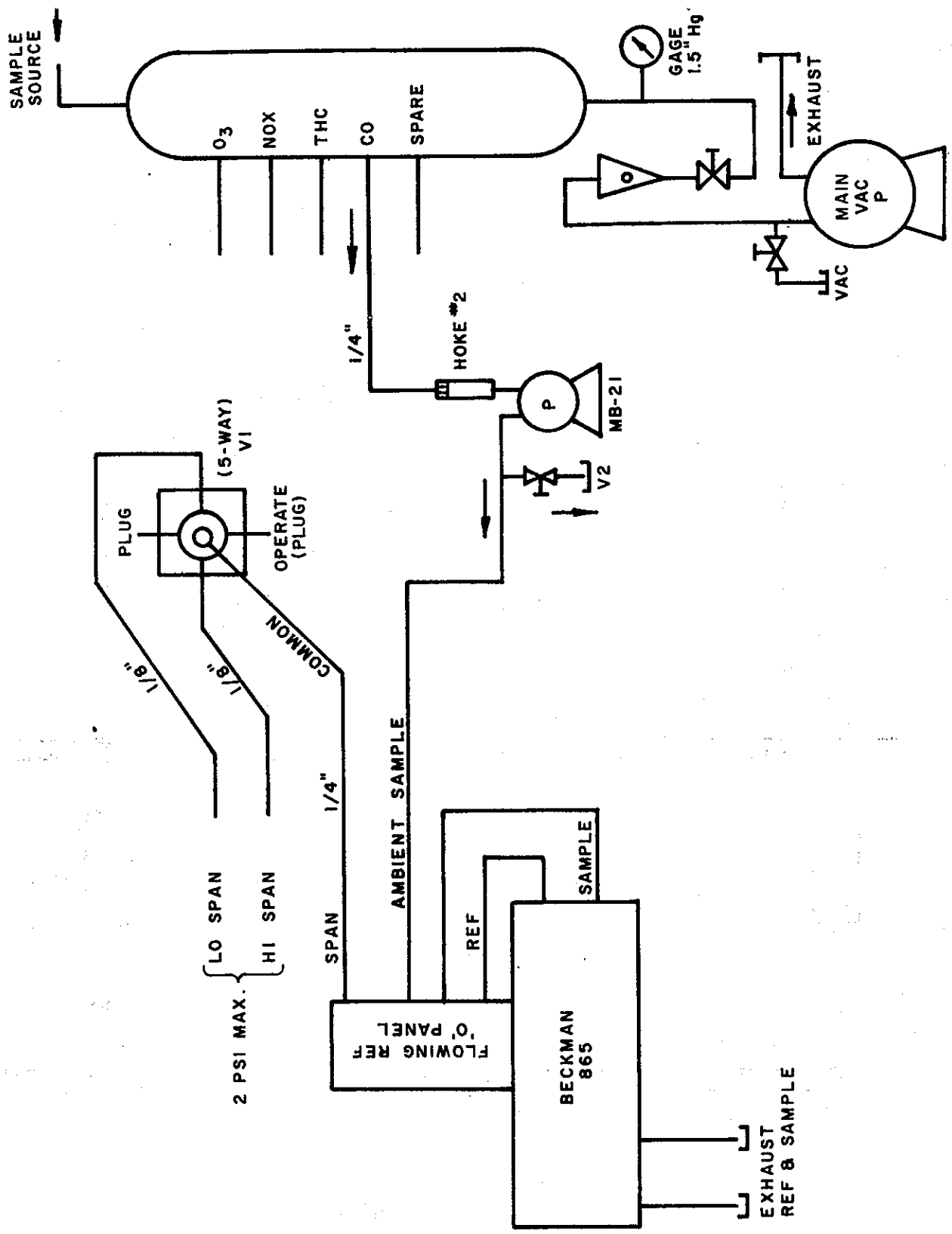
Regulator
Inlet fittings - 2 each CGA350 - CO span
1 each CGA540 - "O" Air
1 each CGA580 - N_2
1 each Metal Bellows pump #MB-21
20977 Knapp Street, Chatsworth (LA) CA 91311
Phone 213/341-4900

8 each B400 1-2 Swagelok male connector 1/8Px1/4T
1 each B400-61 Swagelok Bulkhead Union 1/4T
1 each B-400-P Swagelok Plug 1/4T
1 each Hoke Filters #6315-4FB-1/4" "FNPT" #5 element
1 each Hoke Filters #6312-4FB 1/4" "FNPT" #2 element

Note:

Mount filters with Swagelok and port connectors for easy disassembly

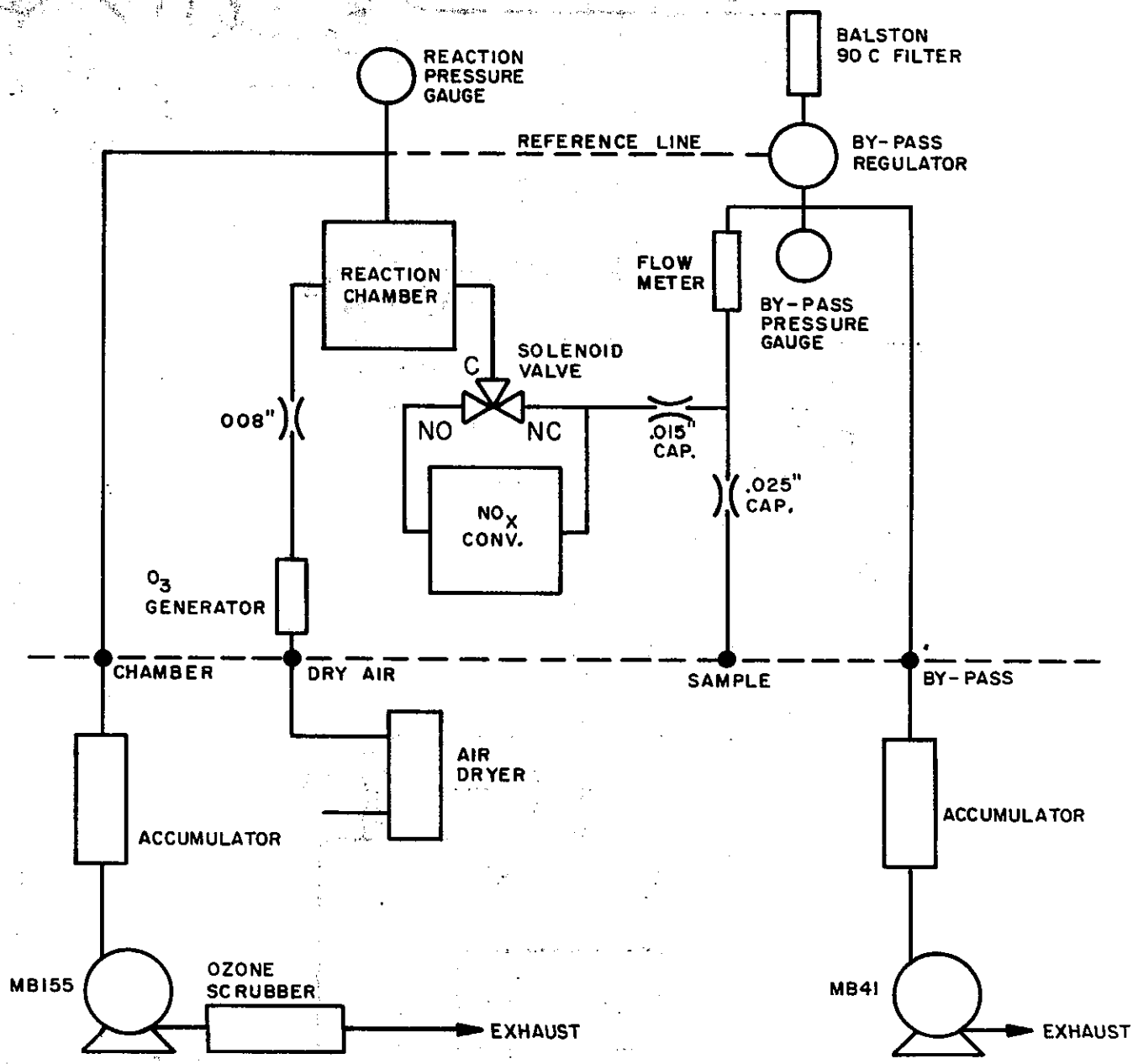
6 each B-400-1-4 Swagelok male connector 1/4Px1/4T
2 each B-401 PC Swagelok Port connector 1/4T
2 each 1/8" NPT Brass pipe close nipple
1 each 1/8" NPT Brass pipe tee
1 each (V-3) B-ORF-2 Whitey Valve 1/8" FNPT (pump bypass)
1 each (V-4) B-ORF-2 Whitey Valve 1/8" (Sample Flow)
1 each (FM) Flowmeter, Fisher Porter #3565A Brass, "O" ring, horizontal screwed, Lucite Shield, with tube #FP 1/8" 16-G-5 with float 1/8" SA for 1410 cc/mAir max, with correction curve for air. G. M. Cooke Associates, 935 Pardee Street, Berkeley, CA 94710 Phone 415/845-5110.
2 each signal jacks
1 each switch SPST
1 each Fuseholder panel mount



CO ANALYZER - BECKMAN 865
WITH FLOWING REFERENCE ZERO PANEL

(NO PROVISION FOR BAG SAMPLE ACCT 'O' BASE)

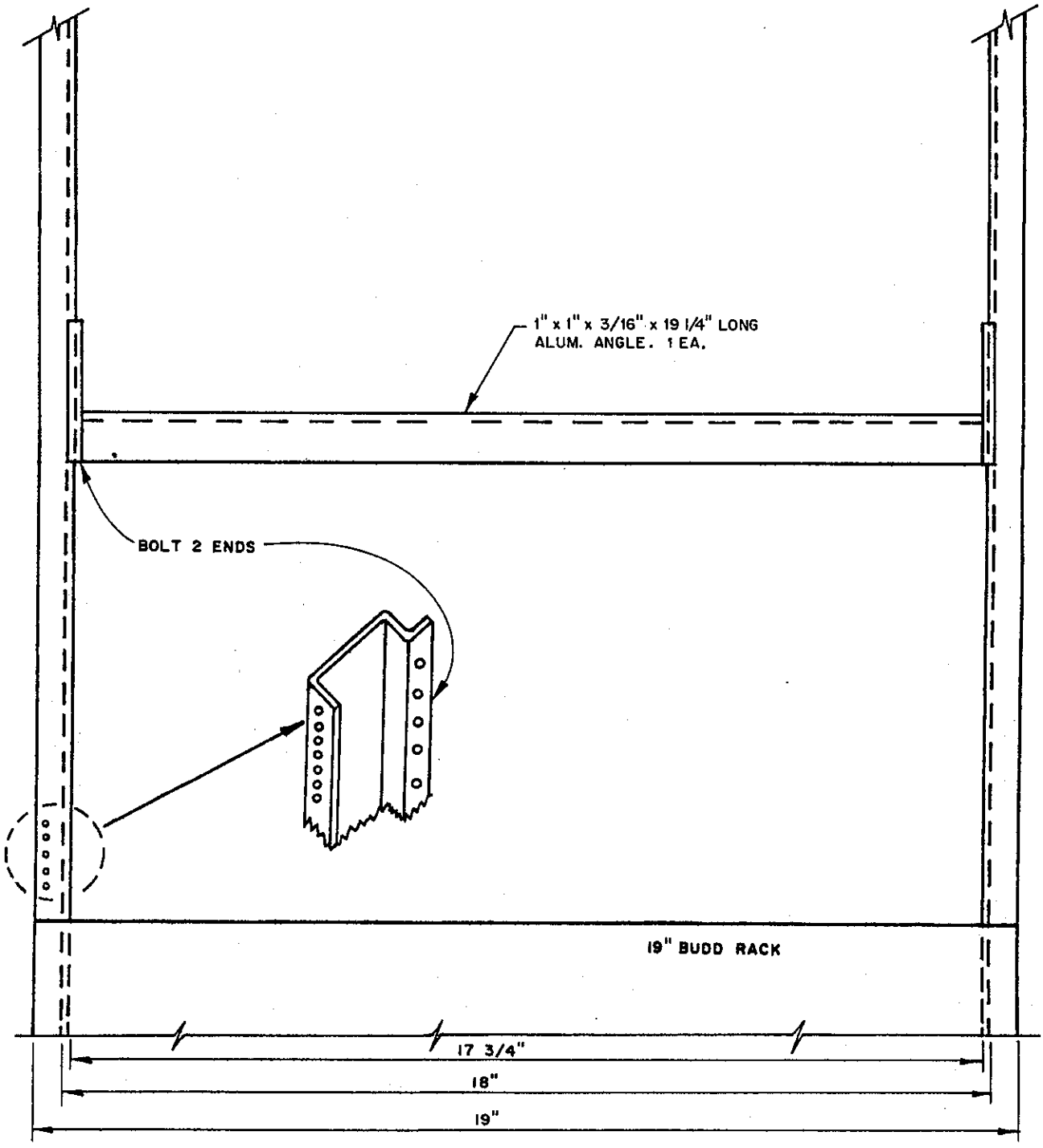
Figure 53



SCHEMATIC FLOW DIAGRAM

MODEL 14, $NO-NO_2-NO_X$ GAS ANALYZER

Figure 54



TECO NOX ANALYZER

SUPPORT FOR REAR OF ANALYZER CABINET

Figure 55

SAMPLE SELECTOR PANEL FOR MODEL 865 CO ANALYZER

The analyzer incorporates a flowing reference cell, designed to minimize the effect of water vapor interference and to eliminate the need for bottled "zero" gas. The reference cell continuously receives background air which has been treated in the catalytic scrubber for removal of all carbon monoxide. The sample cell receives the untreated air containing carbon monoxide. Since both cells contain the same background gases except for carbon monoxide, the resulting differential signal is due to carbon monoxide concentration exclusively.

Calibration Procedure

Zero Adjustment: To obtain a zero reading, CO-free sample air from the catalyst is routed through both sample and reference cells by manual adjustment of valves V_1 and V_2, see Figure 49. Turn valve V_1 to the sample/zero position and valve V_2 to the zero position. Adjust both flowmeters to read 1 CFH. Wait for the meter or recorder to reach a stable reading and adjust the zero control on the analyzer front panel to read zero.

Span Adjustment: To obtain a span reading, span gas from a cylinder is routed through the sample cell and the reference cell receives the CO-free air from the catalyst by manual adjustment of valves V_1 and V_2. Turn valve V_1 to the span position and valve V_2 to the sample/span position. Adjust flowmeters to read 1 CFH. Wait for the meter or recorder to reach a stable reading and adjust the gain control on the analyzer front panel for the correct span reading.

Sample Adjustment: Turn valve V_1 to the sample/zero position and valve V_2 to the sample/span position. Adjust the flowmeters to 1 CFH. The analyzer is now on stream analyzing for CO in the air.

CO Analyzer Model 865 Beckman

Support Components - (1) thru (6) mount in panel face, Figure 50.

1 Flowing zero reference panel (Beckman) 1/8" FNFT (See Figure 49)
2. VI - 5 way Span Valve - Whitey B-432F-2
3. Pump off-on switch
4. Pump fuse
5. Analyzer switch off-on
6. Set Banana plugs for signal output

Pump system (7) thru (9) mounts separately.

7. Pump Metal Bellows MB -21
8. V2-Sample air bypass valve - Whitey ORF-2
9. Hoke Filter #63124FB-#2 element 1/4" FNPT

Note: Mount filter with Swagelok fittings and port connector for easy disassembly for cleaning.

The pump assembly mounts on the wheel well or bottom of the rack where convenient.

One duplex outlet is required. Mount for convenience one outlet wired through a panel switch for the analyzer, the other outlet through the pump switch and fuse.

Mark outlets for their use i.e., (1) pump (2) analyzer

865 Beckman CO Analyzer Parts List

"O" Reference panel - supplied by Beckman
1 each Pair signal jacks
1 each fuseholder - panel mount
2 each switch SPST
1 each (VI) B-43ZF - 2 Whitey valve 5 way 1/8" FNPT
2 each brass 1/8" NPT pipe plugs
2 each B-200 1-2 Swagelok male connector 1/8 Pxl/8T
4 each B-400 1-2 " " " " 1/8Pxl/4T
1 each Hoke filter - #6312-4FB-1/2"FNPT #2 element
2 each B-400-1-4 Swagelok male connector 1/4Pxl/4T
1 each B-401 PC Swagelok post connector 1/4T
2 each 1/8" NPT brass pipe close nipple
1 each 1/8" NPT Brass pipe TCC
1 each Metal Bellows pump #MB21
20977 Knapp Street, Chatsworth (LA) CA 91311
Phone 213/341-4900
1 each (V-2) B-ORF-2 Whitey Valve (pump bypass)
2 each B-200-1-4 Swagelok Male connector 1/4Pxl/8T
2 each Victor regulations VTS 400B, 2 stage
Stainless Steel diaphragms, 350 cga inlet fittings
Northern California - Moore Bros.
69th and Q Streets, Sacramento
Phone 916/452-6431

Diasibi O_3 Analyzer

The model 1003AH Dasibi Analyzer should have a flowmeter and Thomas pump, model #106CE050651TFE. If not so equipped, order the flowmeter and pump from Dasibi Corp., and remove the Rotron Centrifuge pump. In some models of Dasibi Analyzers, the Thomas pump will not fit inside the analyzer, but it can be mounted separately on the outside rear of the cabinet. This makes the O_3 Analyzer self-contained with no support equipment needed. Connect 1/4" OD teflon (FEP) from the O_3 fitting on the sample manifold to the instrument.

One 115 volt outlet is required. (Pump wires to the instrument, separate pump switch is optional.) Provide one pair of output signal jacks in the trim strip above the Analyzer. Connect them parallel to the Analyzer output signal terminals.

Mount the starting capacitor and the pump in the chassis. Connect the power lead to the "Mother Board". If your analyzer is a model that does not have room in it to mount the Thomas pump, then mount the capacitor only in the chassis. A small base can be fabricated for the pump and bolted to the back of the chassis. Base size 4" x 8 1/2". Be sure to insulate the wiring and connect a ground wire to the pump. The Dasibi O_3 analyzer must be equipped with a Thomas pump for van operation.

Parts

1 pair signal jacks.

Teco NO_x Analyzer

This instrument comes as a complete package, with pumps, scrubber, and drier. Connect a 1/4" OD teflon (FEP) line from the NO_x fitting at the sampling manifold, then connect to the instrument sample fitting. There is space below and behind the instrument, when mounted in the rack, for the pumps, scrubber, and drier. Pumps mount on the wheel well; the scrubber and drier mount to the back of the instrument rack. One 115 volt outlet is required for each instrument.

Mount the pump power switch and fuse on the main flow panel.

Provide 3 pairs of signal jacks. These are to be mounted over the instrument meter (upper drawer). Place each pair of jacks on a 3/4" centerline. This is STANDARD spacing. Wire each signal (NO-NO_2-NO_x) parallel to the instrument signal wiring at the rear of this drawer.

Parts

3 pair signal jacks.

Bendix 8201 THC Analyzer

Criteria

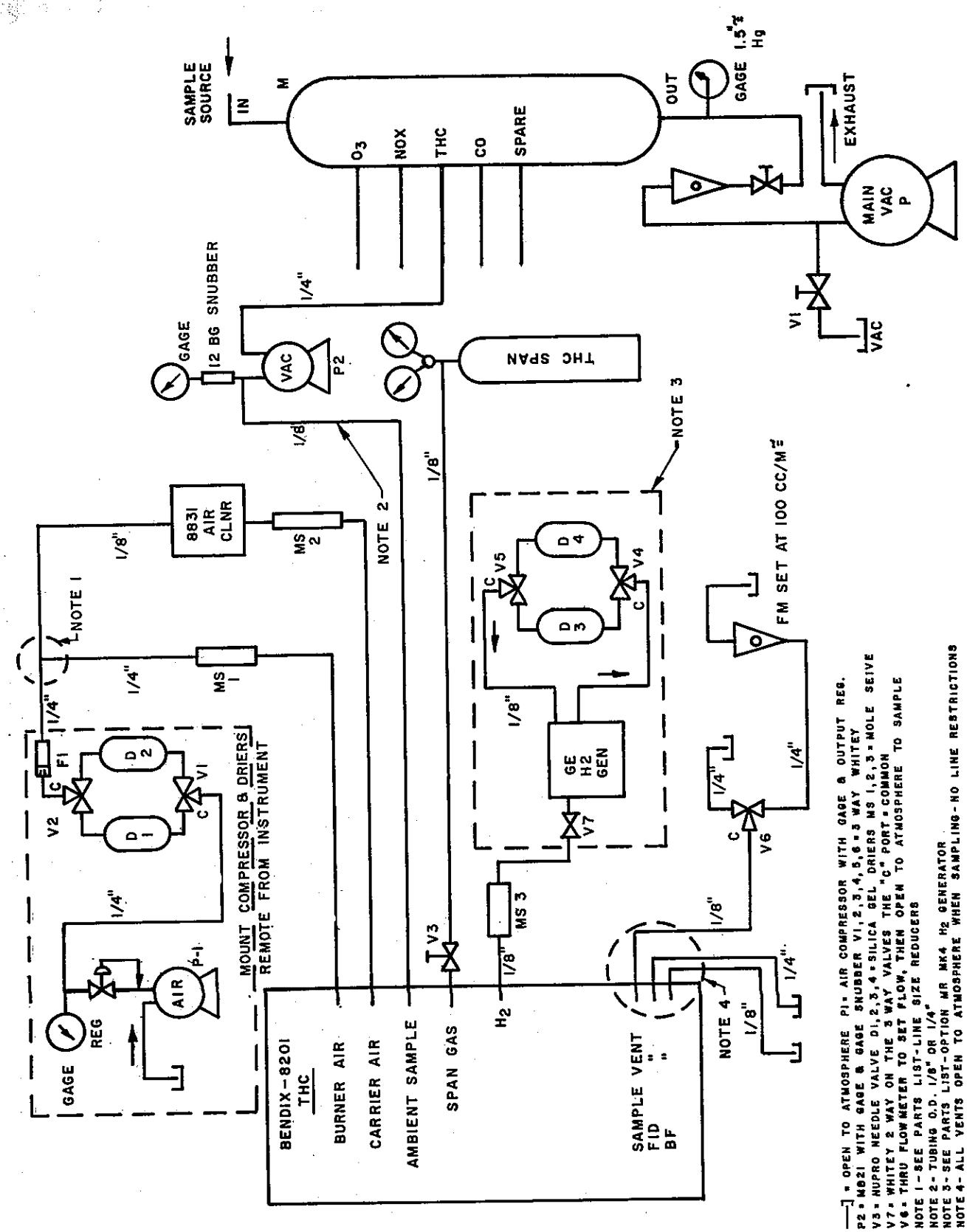
This analyzer is a gas chromatograph and requires a considerable amount of support equipment and plumbing. All fittings exposed to sample span and support gases must be washed in methanol, rinsed in distilled water, and dried with nitrogen. This prevents system contamination with oils and excess hydrocarbons. LEAK TEST ALL HYDROGEN SYSTEMS WITH CARE - EXPLOSIVE!!!!!

Flow - See piping system layout and parts list (Figure 56).
Signal - Parallel the THC, CH_4, Reactive HC, Signal from the instrument to the jacks on the front of the THC support panel, and also to the recorders - 3 pair jacks with 3/4" spacing.

Power - (2 each 115 volt outlets required)
#1-one outlet for the instrument. The sample pump plugs into the instrument and is switched from the instrument.
#2-one outlet for a service cord to the Duplex outlet box on the support drawer. This powers the H_2 generator and clean air package, Model 8831.

The support drawer mounts on slide type drawer mountings. These are the same slides as the model 8201 analyzer, then both units can be slid out of the rack together, for service access.

The Air Compressor includes regulator and gage. The compressor and tank can be separated, and placed under the van in front of the left rear wheel well. Power is piped on the left side of the van to the wheel well. Locate the switch and fuse on the main flow panel.



THC-ANALYZER PIPING SYSTEM

1 REQ'D.

—] = OPEN TO ATMOSPHERE P1 = AIR COMPRESSOR WITH GAGE & OUTPUT REG.
P2 = M821 WITH GAGE & GAGE SNUBBER V1,2,3,4,5,6 = 3 WAY WHITEY
V3 = NUPRO NEEDLE VALVE D1,2,3,4 = SILICA GEL DRIERS MS 1,2,3 = MOLE SEIVE
V7 = WHITEY 2 WAY ON THE 3 WAY VALVES THE "C" PORT = COMMON
V6 = THRU FLOWMETER TO SET FLOW, THEN OPEN TO ATMOSPHERE TO SAMPLE
NOTE 1 - SEE PARTS LIST-LINE SIZE REDUCERS
NOTE 2 - TUBING O.D. 1/8" OR 1/4"
NOTE 3 - SEE PARTS LIST-OPTION MR MK4 H2 GENERATOR
NOTE 4 - ALL VENTS OPEN TO ATMOSPHERE WHEN SAMPLING - NO LINE RESTRICTIONS

Figure 56

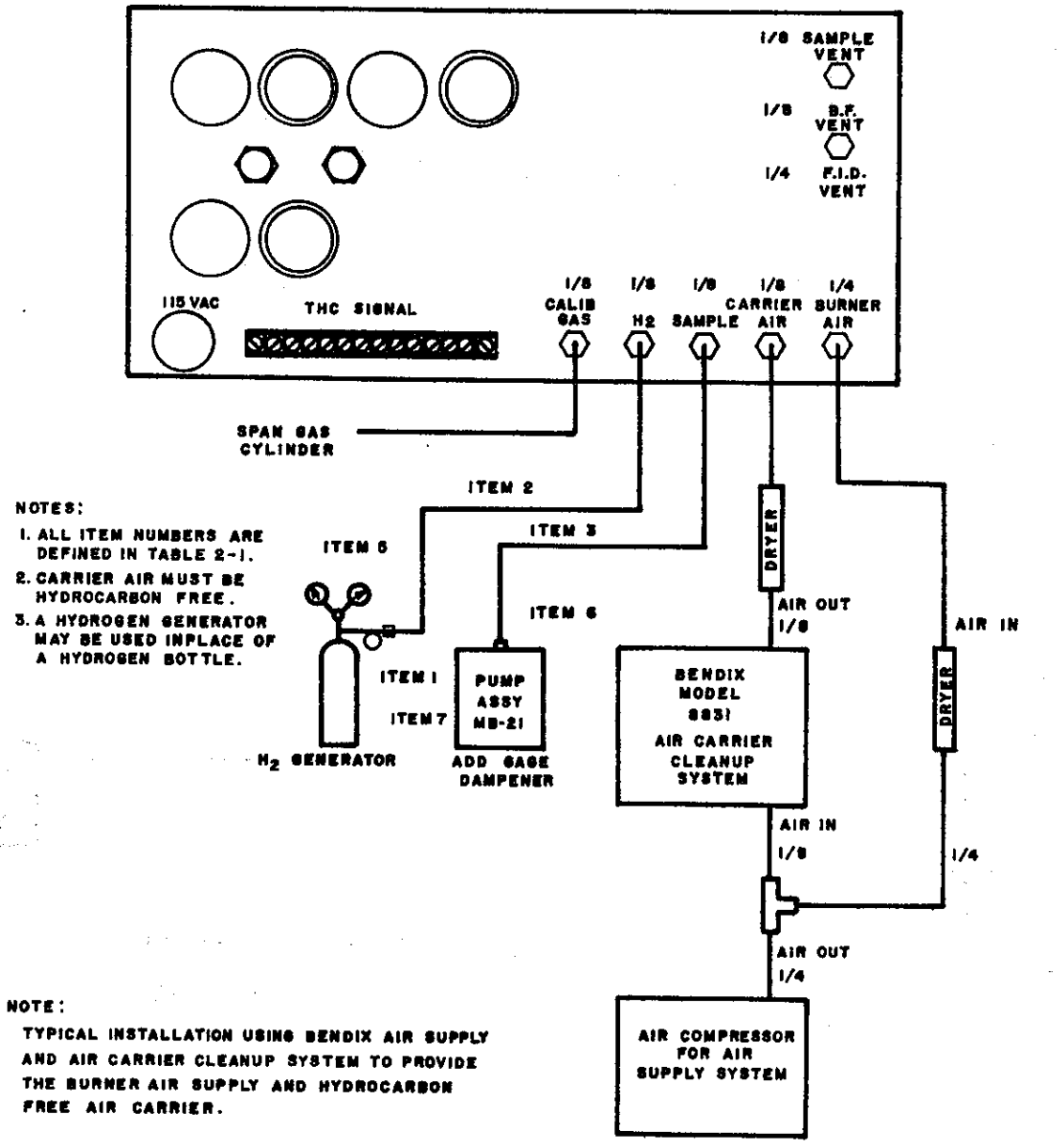
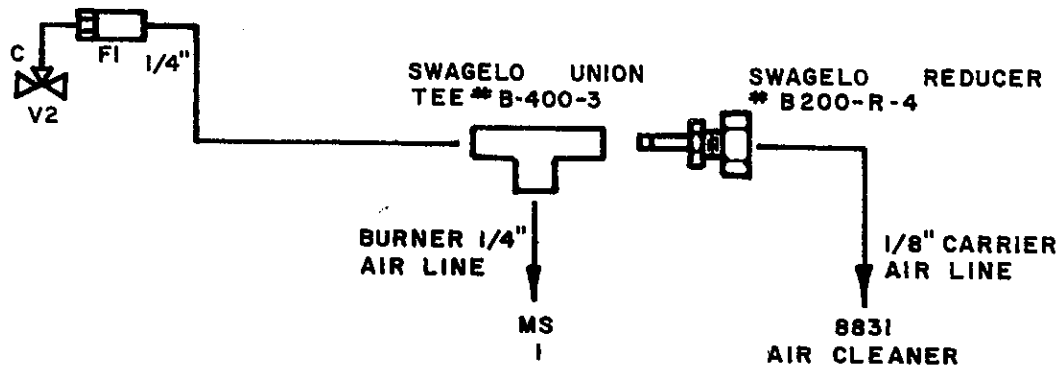


DIAGRAM FOR BENDIX CO MANUAL

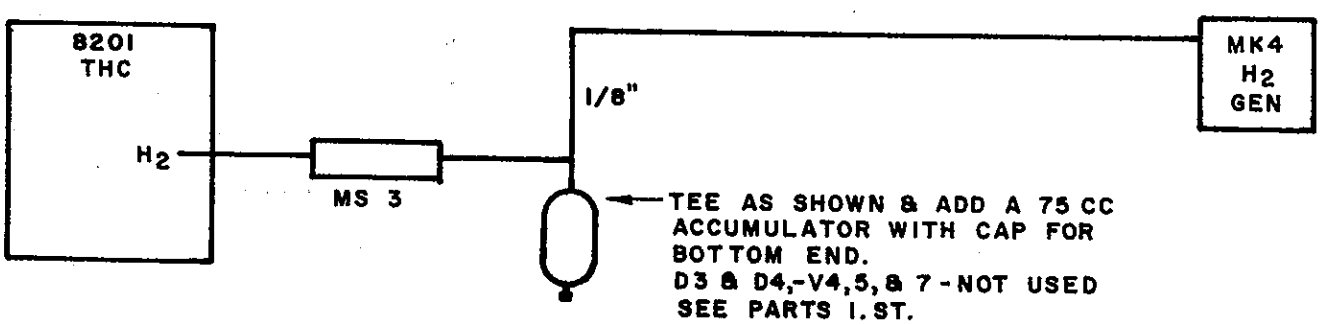
REFERENCE ONLY

Figure 57

NOTE 1 – REDUCE LINE SIZE AFTER AIR DRIERS.

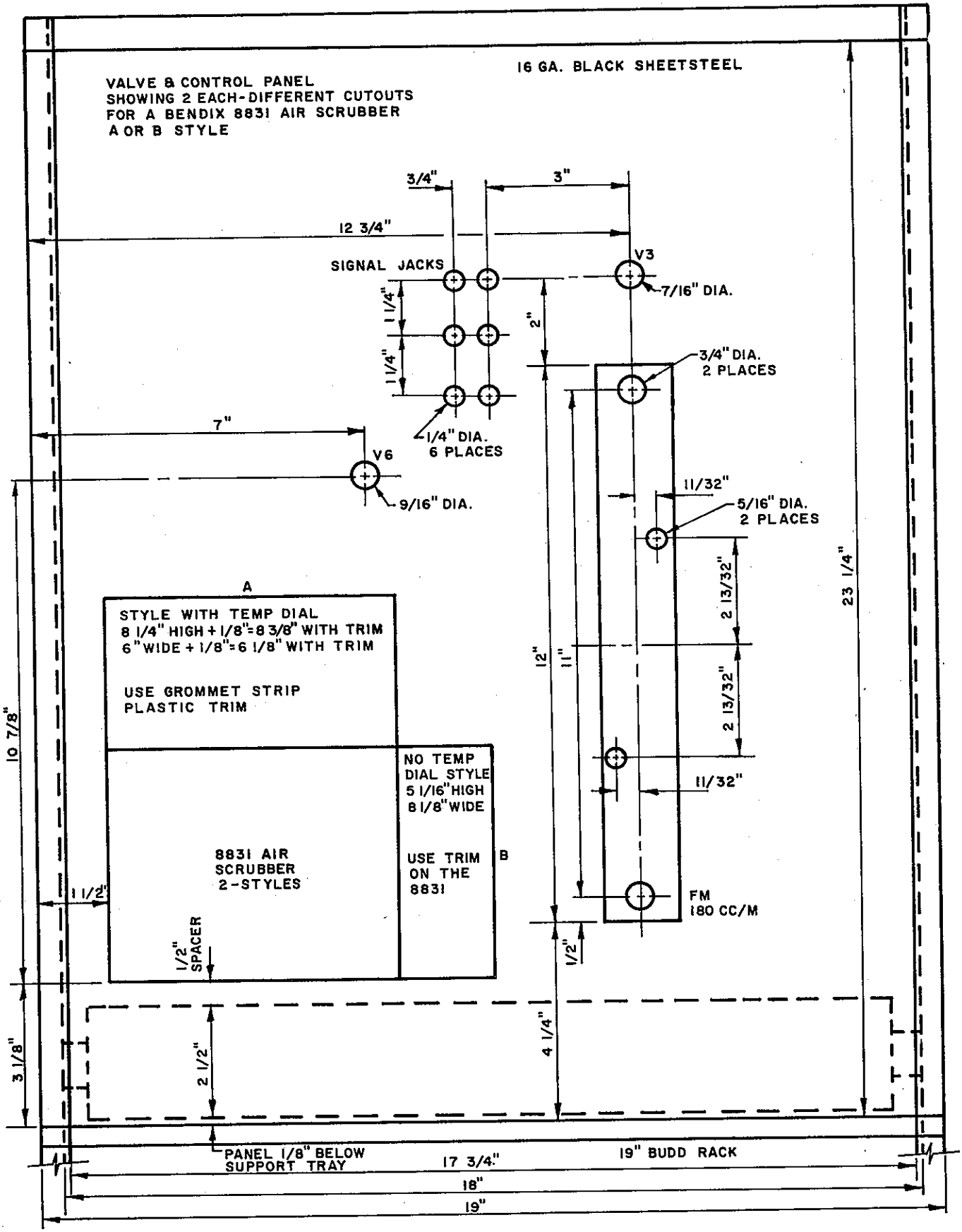


NOTE 3 – OPTION, MILTON ROY MK4 H_2 GENERATOR.



BENDIX 8201 THC-ANALYZER AIR SYSTEM

Figure 58



8201 BENDIX THC ANALYZER

Figure 59

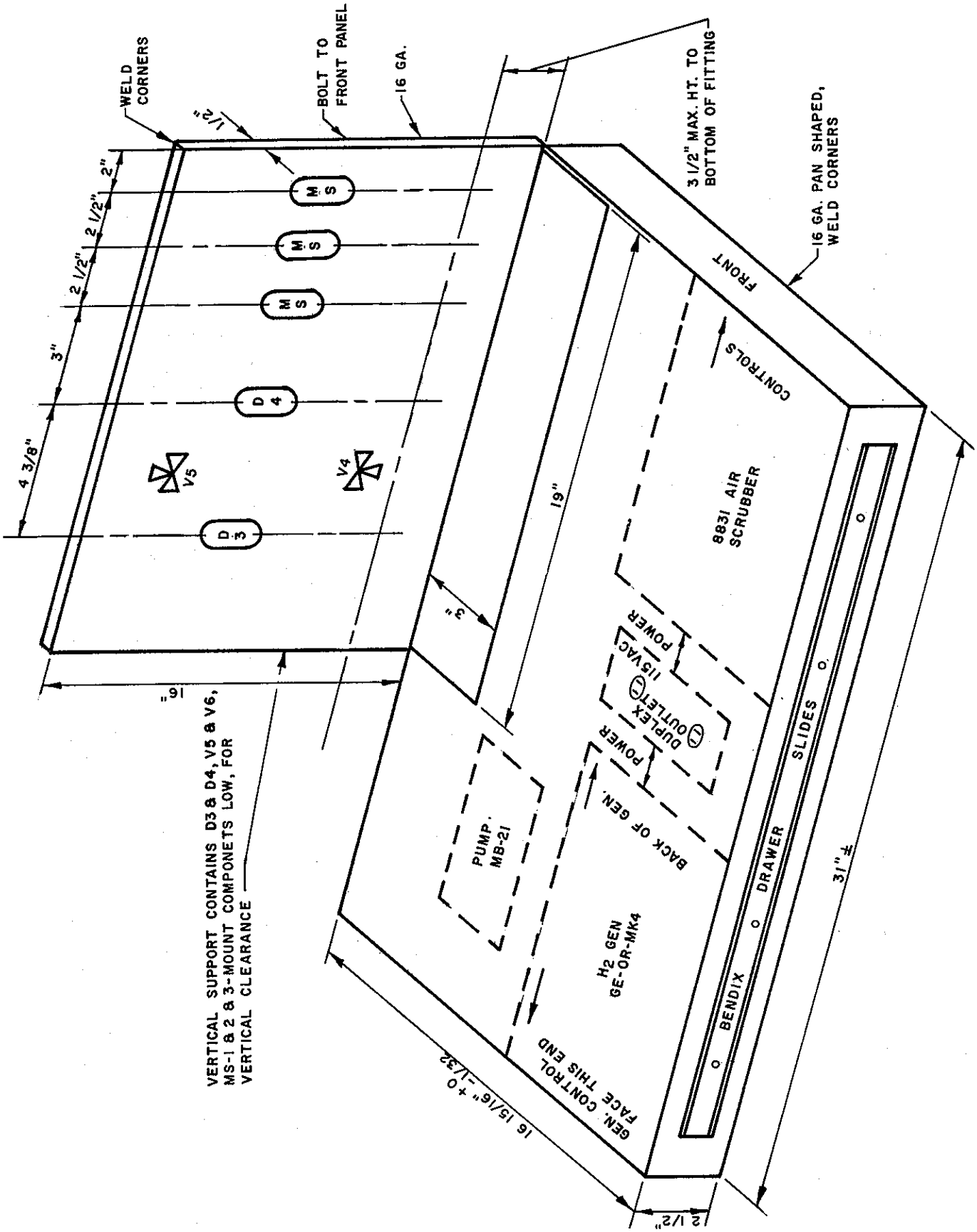
Bendix 8201
THC Analyzer
Parts List - Piping System

Air System

1 each Air compressor, Gast Model #1-HAB-11-M100X, oilless, with output pressure gage and regulator. (P-1)
1 each (F1) Hoke filter 6312F4B #2 element
2 each B400-1-4 Swagelok male connector 1/4" x 1/4T
2 each (V1, V2-) #B-42S4 Whitey valve 3 way 1/4T
2 each (D1 & D2) Silica gel driers
4 each B400-1-2 Swagelok male connector 1/8Px1/4T
1 each B400-3 Swagelok union tee 1/4T
1 each B200-R-4 Swagelok reducer 1/8Tx1/4T
1 each 8831 Bendix clean air package furnished by Bendix
4 each B400-A-4ANF Swagelok to AN adapter 1/4 swage x 1/4T-AN
2 each (MS-1&MS-2) drier-filter #FD-0022 - See Vendor list
2 each B400-6 Swagelok union 1/4T
2 each B400-6-2 Swagelok reducing union 1/4Tx1/8T
1 each B401-A-4 Swagelok adapter tube-pipe 1/4Px1/4T

Sample System

1 each Metal Bellows pump #MB-21 with gage furnished by Bendix (P2)
1 each #12BG-gage Snubber
1 each 1/8" NPT close nipple stainless
1 each 1/8" NPT tee stainless
1 each #55-400-1-2 Swagelok male connector 1/8Px1/4T
1 each #55-200-1-2 " " " " " 1/8Px1/8T

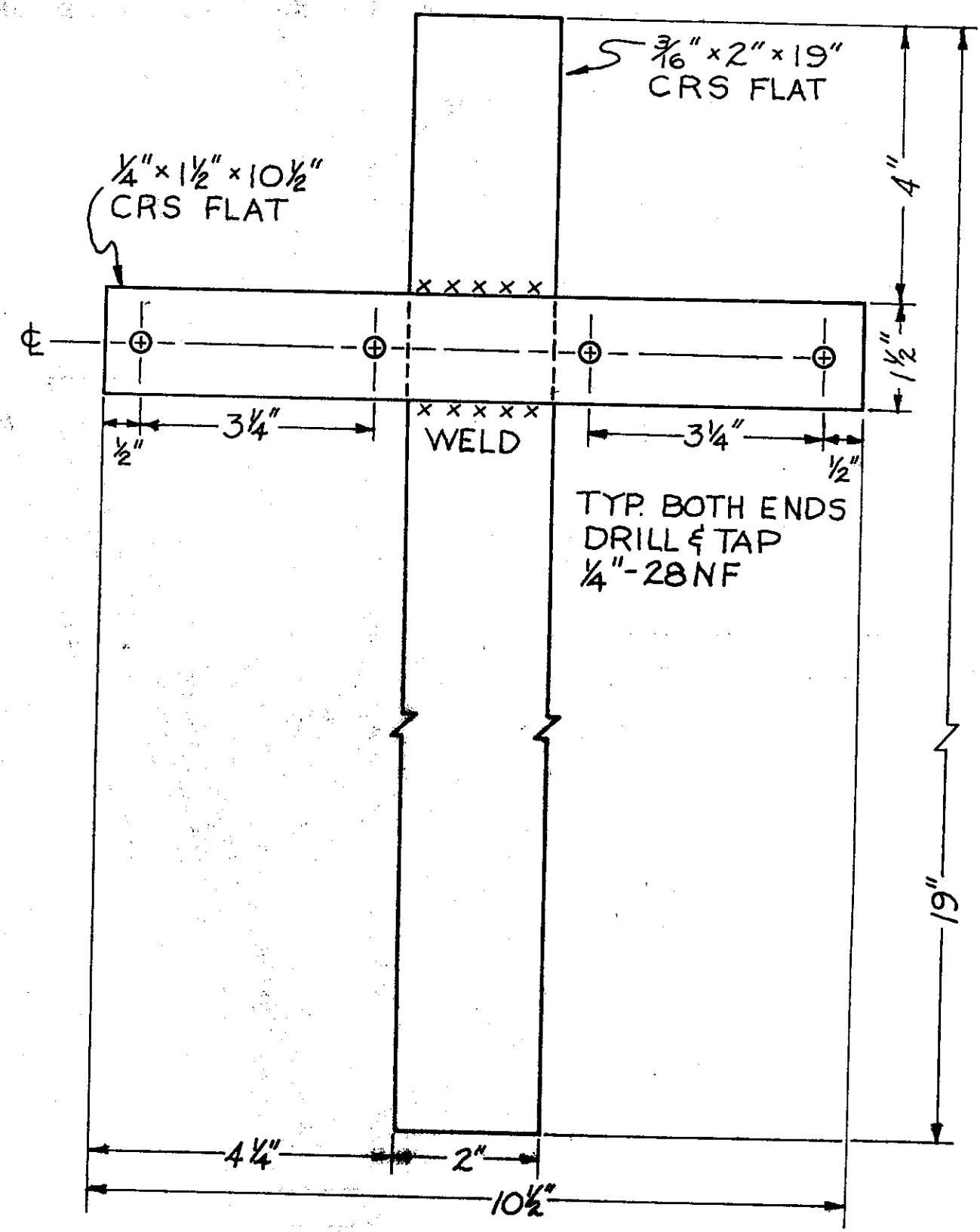


BENDIX 8201 THC SUPPORT DRAWER

(1 REQD.)

16 GA. BLACK SHEETSTEEL

Figure 60



AIR DRIER MOUNTING BRACKET

Figure 61

Span System

1 each Victor pressure regulator VTS400B
2 stage, stainless steel diaphragms, 350 cga inlet fitting - see vendor list.

1 each #B200-1-4 Swagelok male connector 1/4Px1/8T
1 each (V3) #SS-2-SG Nupro Valve, .031 orifice, straight pattern 1/8T
This option requires the following parts.
Option - Ball shutoff valve on the output of the regulator.
1 each B-42F2 Whitey valve 2 way 1/8 FNPT
1 each 1/8" NPT brass close pipe nipple
1 each Brass NPT pipe bushing 1/8" x 1/4"
1 each B200-1-2 Swagelok male connector 1/8Px1/8T

H_2 System - G.E. Generator

1 each (MS-3) drier filter #FD-0022 - See vendor list
2 each B400-A-4ANF Swagelock to AN adapter 1/4 Swage x 1/4T-AN
2 each B400-6-2 Swagelock reducing union 1/4Tx1/8T
1 each (V-7) B41S2 Whitey valve 2 way 1/8T. Mount on generator alongside the outlet. Pipe the outlet H_2 to this valve. (H_2 line shutoff)

2 each (V4 & V5) B-41xS2 Whitey valve 3 way 1/8T
2 each (D3 & D4) silica gel driers

H_2 System - Milton Roy MK-4 Generator

1 each (MS3) drier-filter #FD-0022 - See vendor list
2 each #B400-6-2 Swagelok Reducing Union - 1/4Tx1/8T
1 each #HDF-4-75-304 Whitey sample cylinder stainless 75CC Vol.
1 each #B-400-P Swagelok plug 1/4T
1 each #B-200-3-4 TMT Swagelok male run tee 1/4Px1/8T

Sample Vent System, Calibration-Sample Flow

1 each (V-6) #B42xS4 Whitey valve 3-way 1/4T
1 each #B200-R-4 Swagelok Reducer 1/8Tx1/4T
2 each #B400-1-4 Swagelok male connector 1/4Bx1/4T
1 each Flowmeter Fisher Porter Tube #FP 1/16"-16-G-5 for
185 cc/M air with curve

VENDORS

Drier #FD-0022
Filter drier - mole sieve 5A, #FD-0022,1/4" AN, male thread
Stock spares in this item, so that these can be replaced without down time. Used driers can be rejuvenated by heating to 300°F and back flushing with N_2 for 8 hours.
TEK-LAB Inc.
9138 Mammoth Drive
Baton Rouge, LA 70814

Silica-Gel
Silica-Gel, 42 grade, 6-16 mesh, indicating
Type - Reusable
4 each #5 cans @ $2.10 per pound
R. J. Schoots Associates
P. O. Box 67
Moraga, CA 94556

Victor Regulators
Northern California
Moore Bros
69th and Q Streets, Sacramento, CA

Swagelok-Fittings, Whitey and Nupro Valves
Northern California
Oakland Valve & Fitting Company
2387 Estand Way
Pleasant Hill, CA 94523

Tech Ecology* Meteorological Instruments

These instruments are fully electronic and consist of two sensors, mast mounted, and an electrical translator or signal conditioning box which is mounted in the top of the right instrument rack.

The instrument is self-contained and needs only one 115 volt outlet. The wind speed and wind direction sensors will mount individually on a cross arm above the van. Two Cannon type connectors mount through the van wall to carry the wind speed (WS) and wind direction (WD) signals.

These Cannon plugs must be all wired the same, so that calibration can be done on any of the sensors with one standard calibration setup. See and follow attached prints (Figures 73-75).

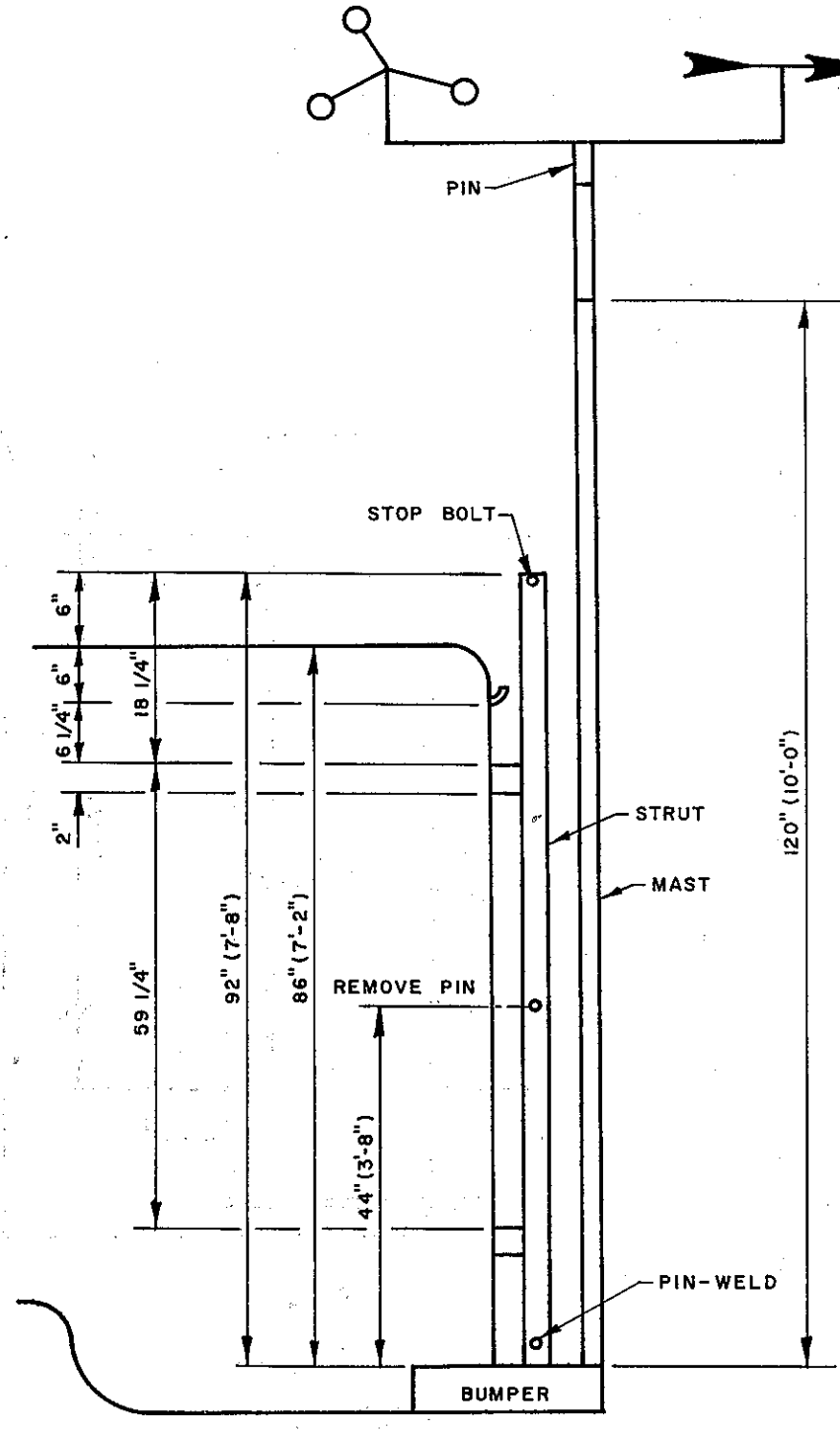
Cable #A5155-W.S. 5 leads
Cable #A5156-W.D. 6 leads

Parts

2 each Cannon type signal plugs (as above)
Met mast and mount, with provision for north orientation
Meteorological Sensors - WS & WD
Bendix-Amphenol wall mounting receptable for mounting through rear wall of van (7 pin). All cables must be connected the same. This is so that one calibration setup will fit all the sensors.

	Cable A 5155 5 wire WS + shield	Cable A 5156 6 wire WD + shield
Pin	Color	Color
A	white	white
B	green	blue
C	yellow	yellow
D	red	red
E	black	black
F	No connection	green
G	shield	shield

*This company now MET-ONE, Sunnyvale, CA.



CALCULATION

MAST = 10'
RISE = 3'-8"
3/4" RD SUPPORT FOR MAST
O.A. INCLUDE CLAMP & BASE
PIN = 45'
TRAVEL TOTAL = 45"+
RISE OF 3'-8" = 89"

MAST AT LOWERED POSITIONS

ABOVE VAN 2'-8"
10'-0" - 7'-2" = 2'-10"
NET ABOVE VAN 5'-6"

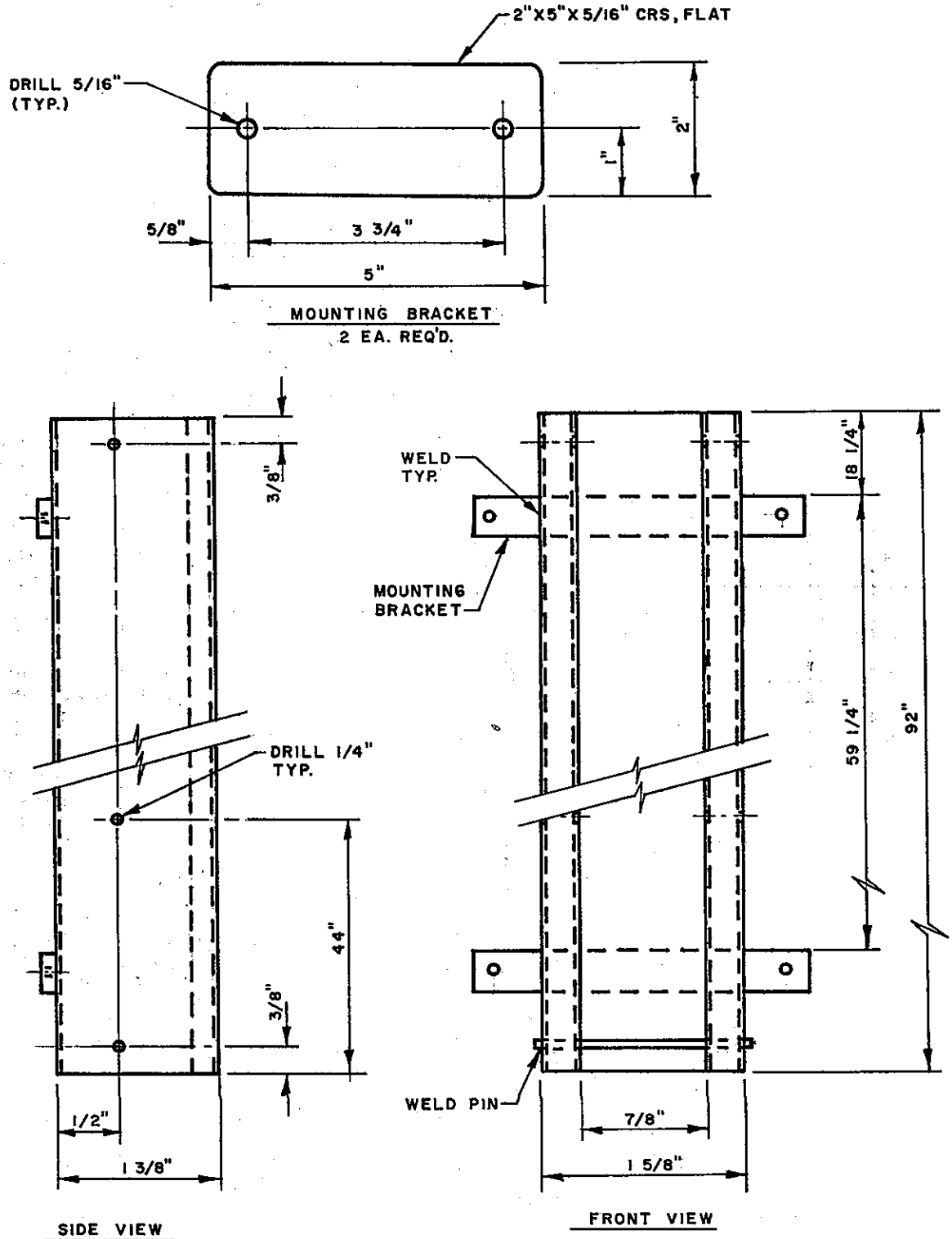
NEED FROM BUMPER 7'-2"
PLUS ABOVE VAN 9'-1"
TOTAL 16'-3"
MINUS 5'-6"
10'-9"
MINUS 7'-2"
RISE = 3'-7"
CALC. = 3'-8"

HEIGHT OF VAN = 9'-1"

HEIGHT OF MET. GEAR WITH THE MAST EXTENDED IS 9'-1" ABOVE THE VAN.

METEOROLOGICAL MAST

Figure 62



NOTE:

1 EA. METEOR MAST SUPPORT : MATERIAL C1200 SUPER STRUT WITH 2 EA. MOUNTING BRACKETS WELDED TO EACH SUPPORT

METEOROLOGICAL MAST ASSEMBLY

Figure 63

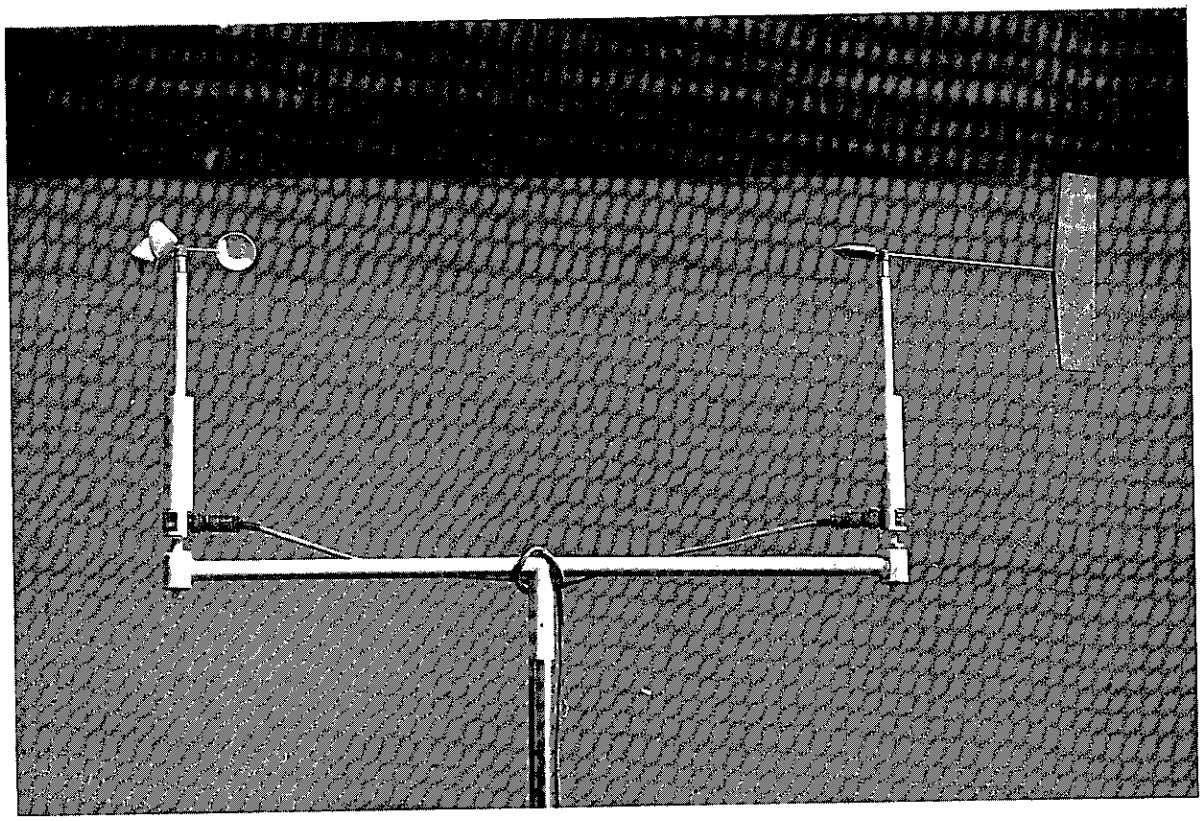
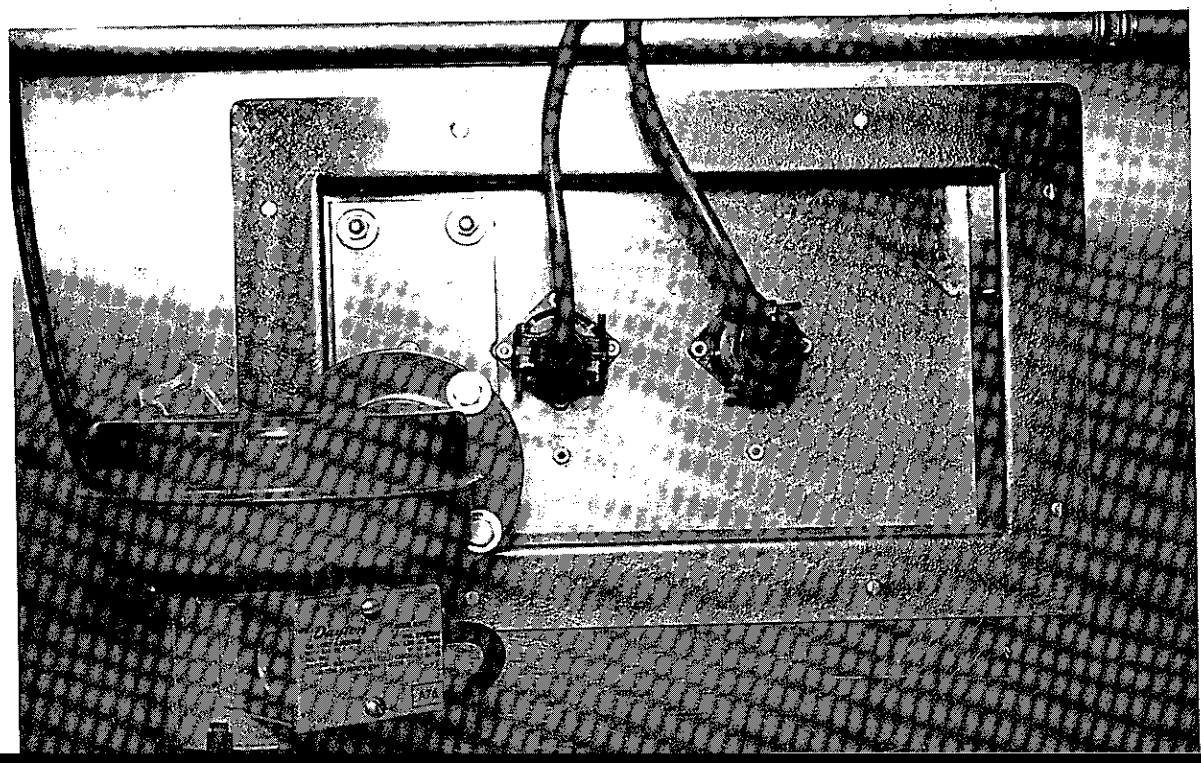
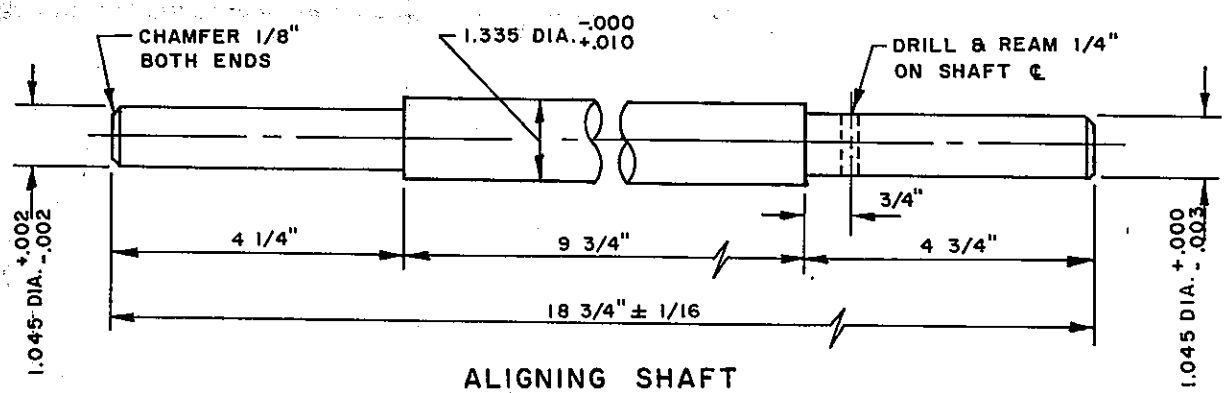


Fig. 64 Meteorological Sensors

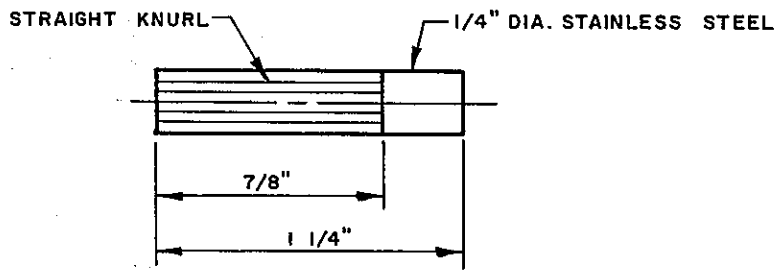




ALIGNING SHAFT

1 EA. REQ'D. 1 3/8" ALUM. RD.

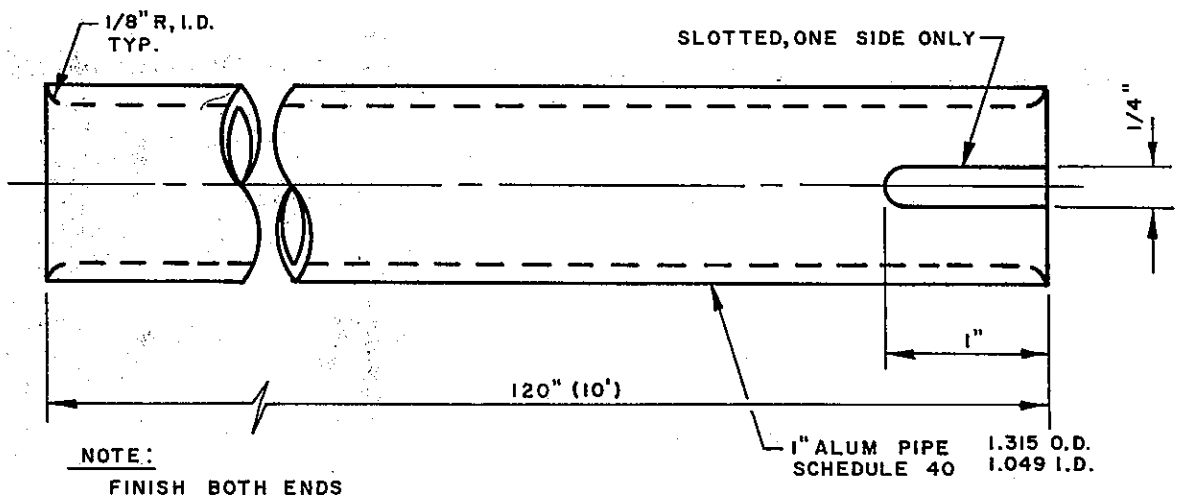
Figure 64



ALIGNING PIN

1 EA. REQ'D.

Figure 65



METEOROLOGICAL MAST

1 EA. REQ'D.

METEOROLOGICAL MAST ASSEMBLY

Figure 66

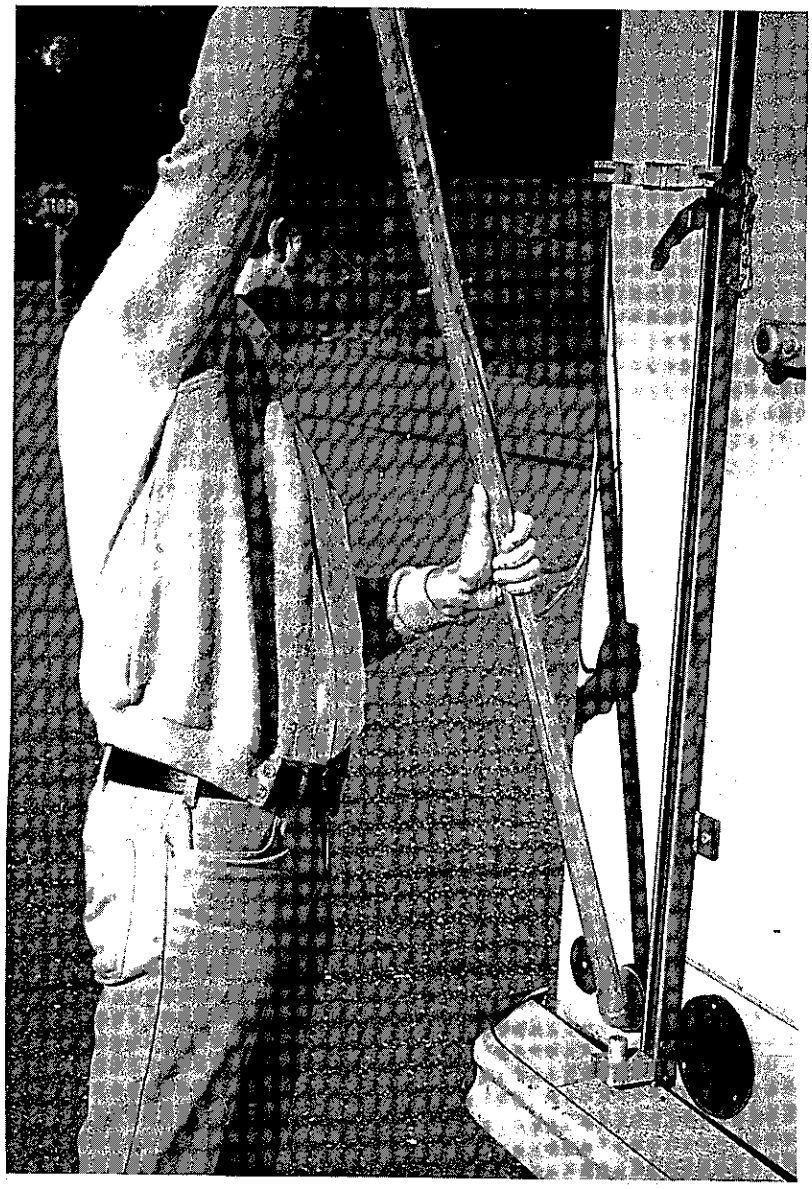


Fig. 67 Meteorological Mast Mounting

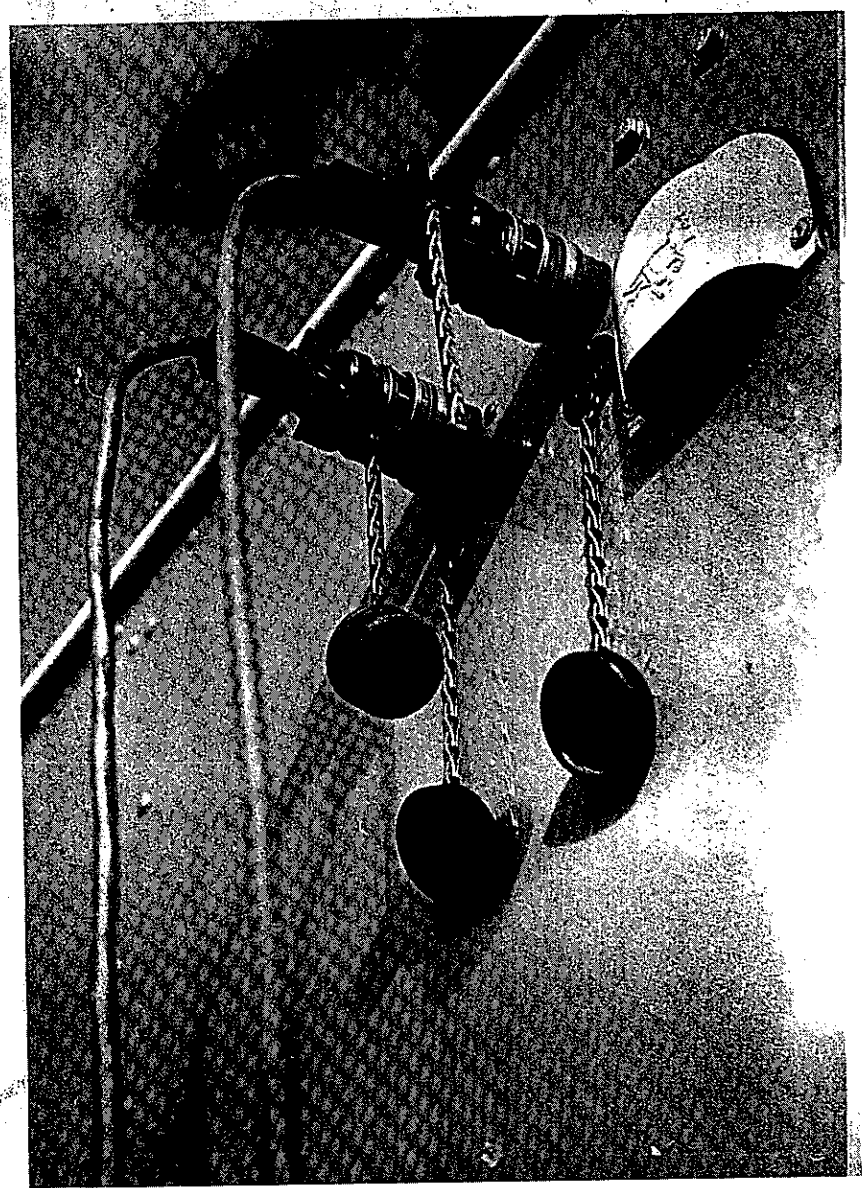
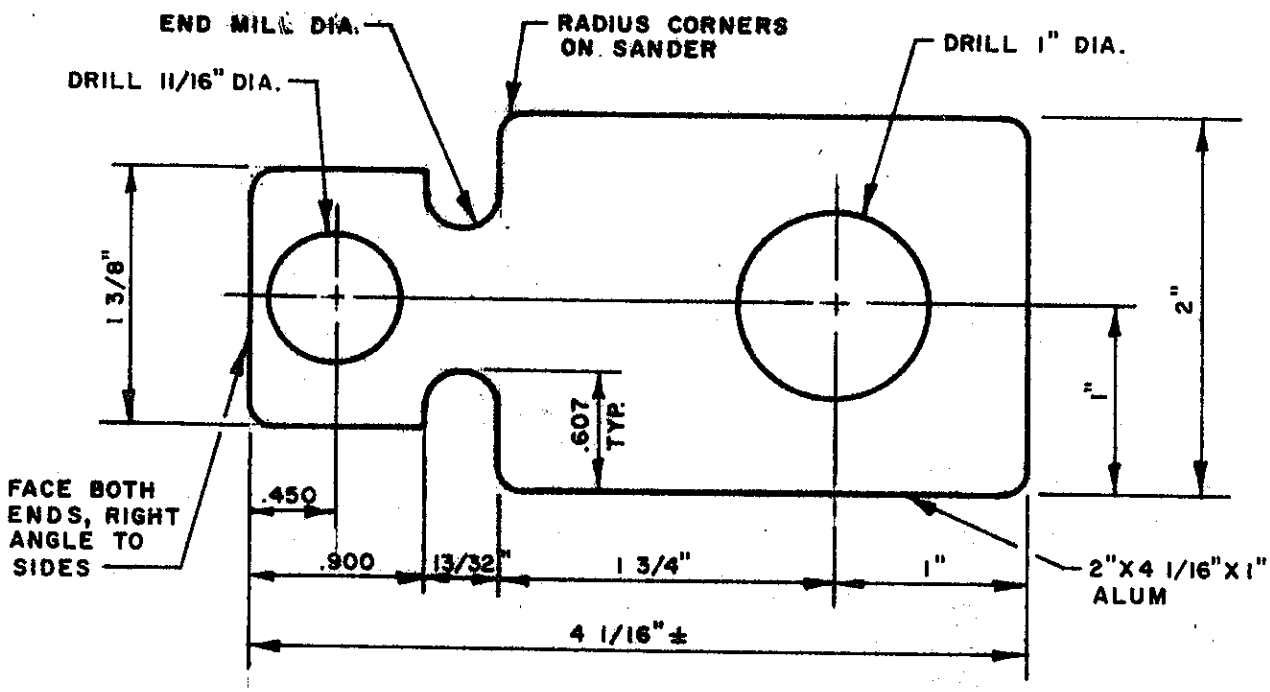


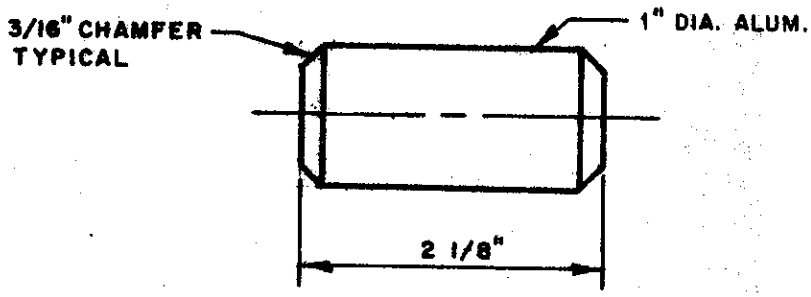
Fig. 68 Meteor. Sensors' Cable Connectors - Outside Van



BOTTOM SUPPORT

1 EA. REQ'D.

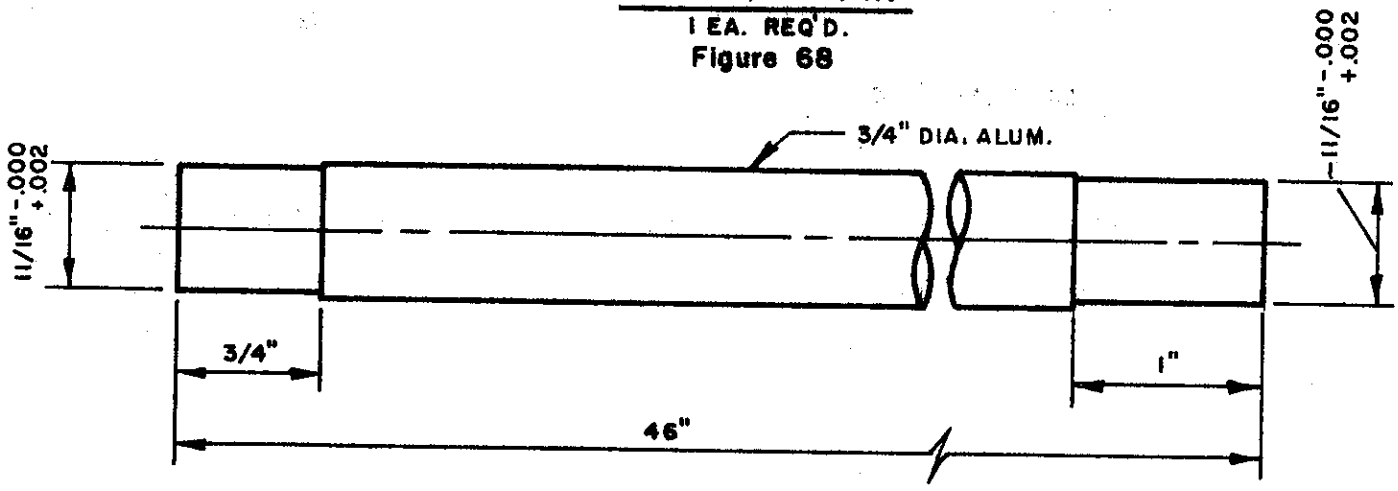
Figure 67



SUPPORT PIN

1 EA. REQ'D.

Figure 68



SUPPORT SPACING SHAFT

1 EA. REQ'D

Figure 69

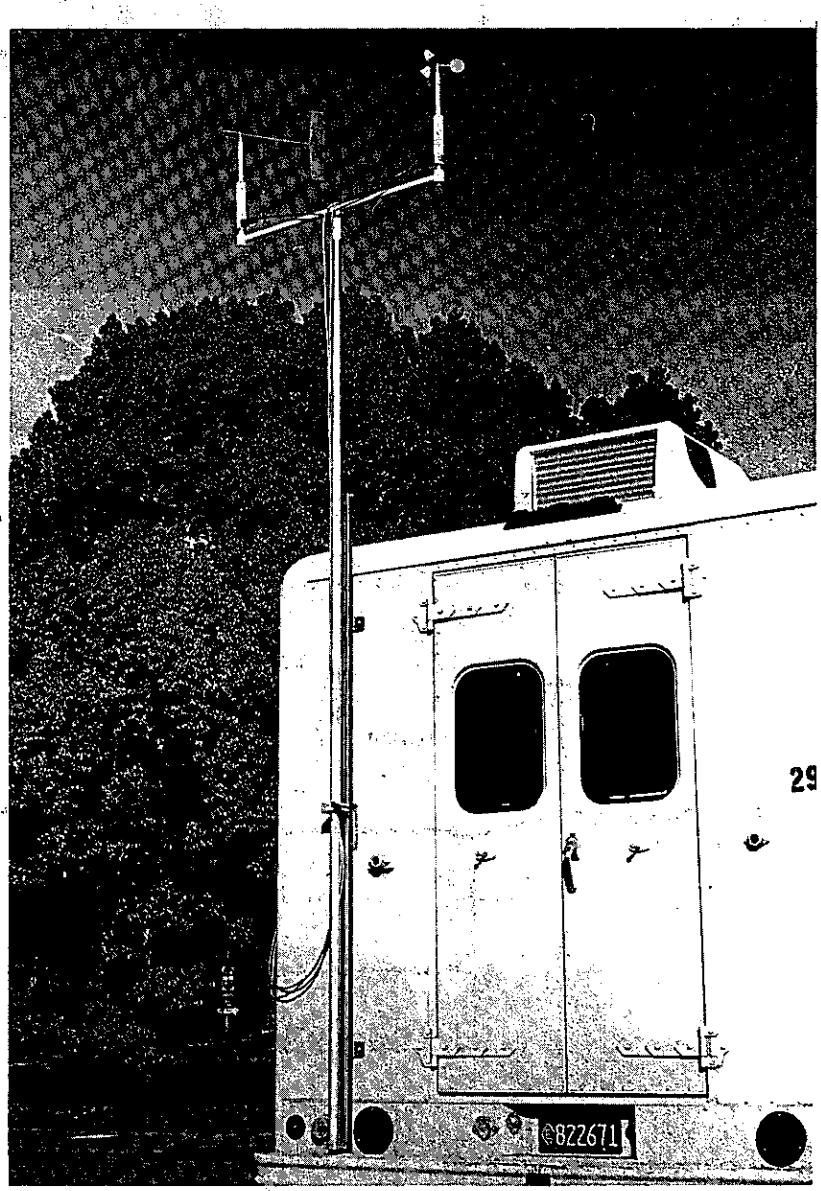
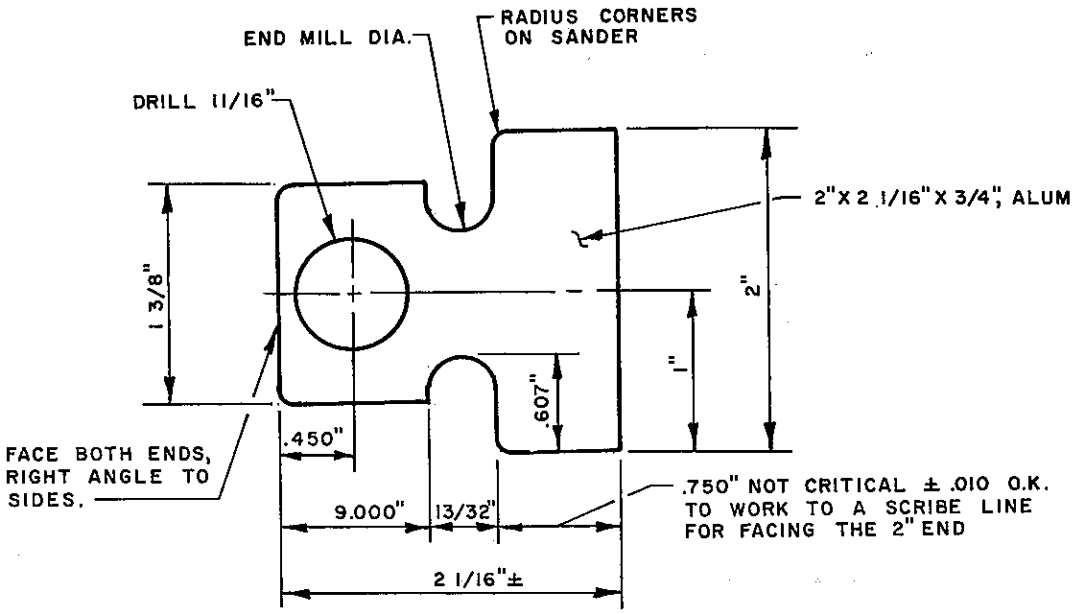


Fig. 70 Meteor. Mast & Sensors Mount in Lower Position

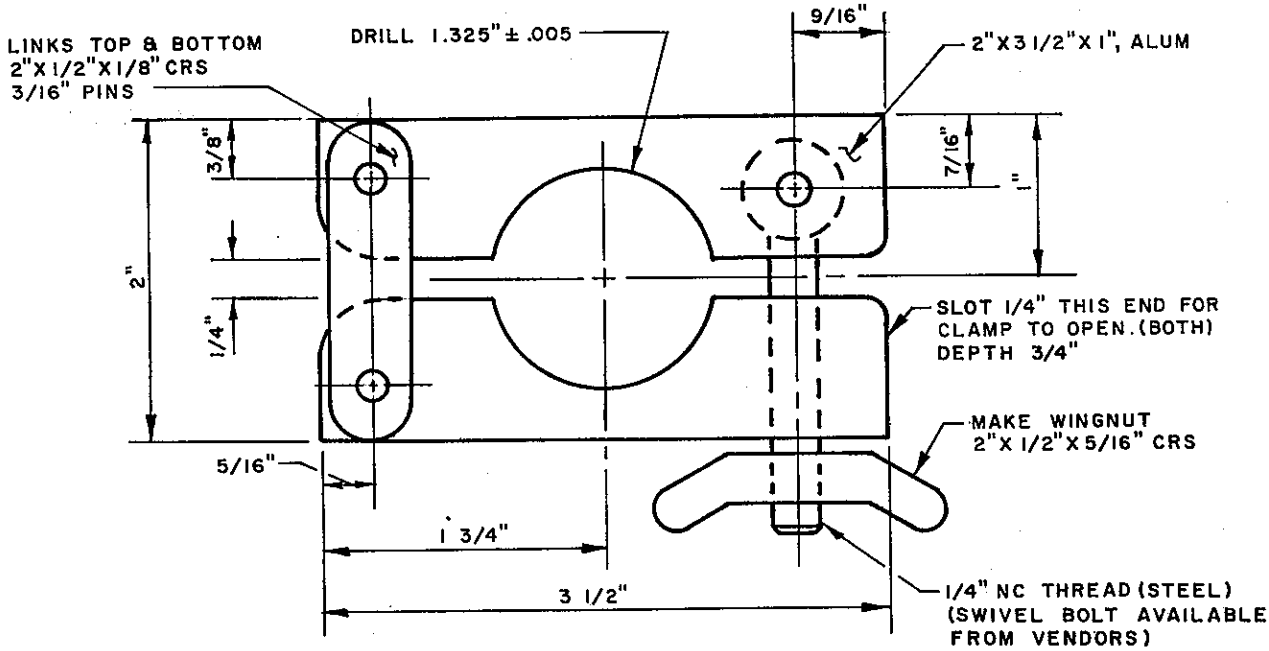


CLAMP SUPPORT

(WELD TO CLAMP ON ℄)

1 EA. REQ'D.

Figure 70



METEOR. MAST CLAMP

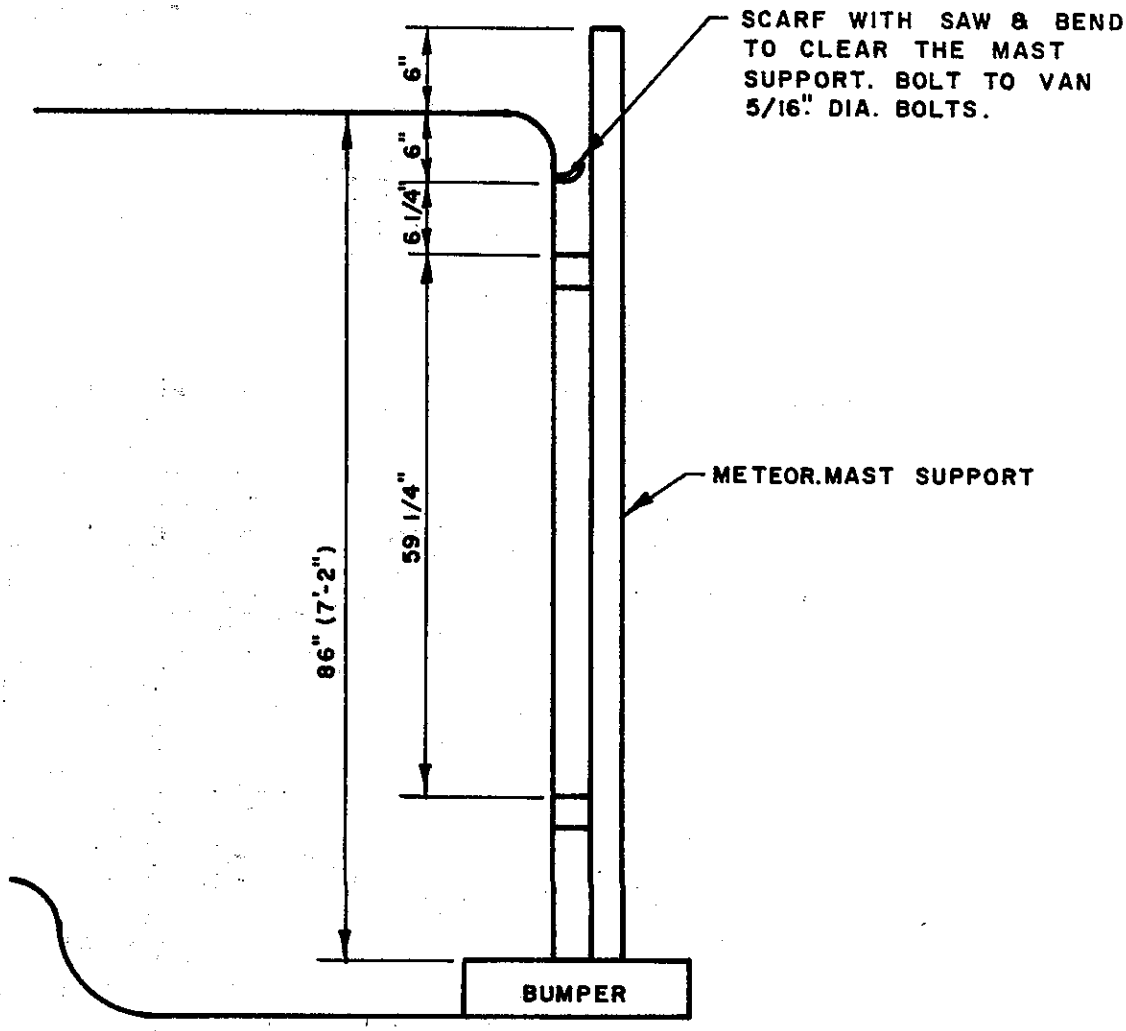
1 EA. REQ'D

METEOROLOGICAL MAST ASSEMBLY.

Figure 71

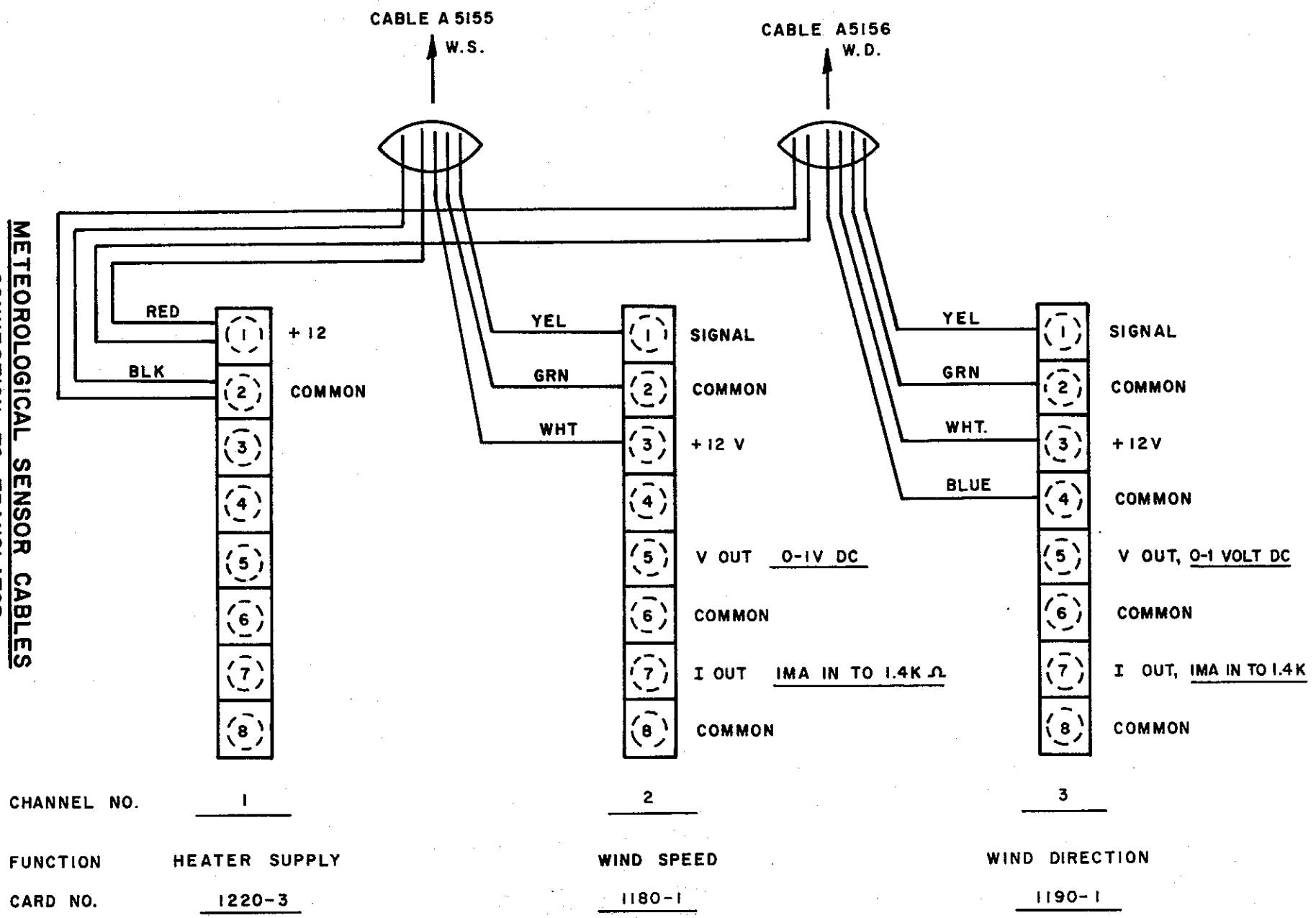
INSTALLATION LOCATION

LEFT REAR CORNER OF THE VAN. FITS BETWEEN THE BACKUP LIGHT AND TAIL LIGHT.

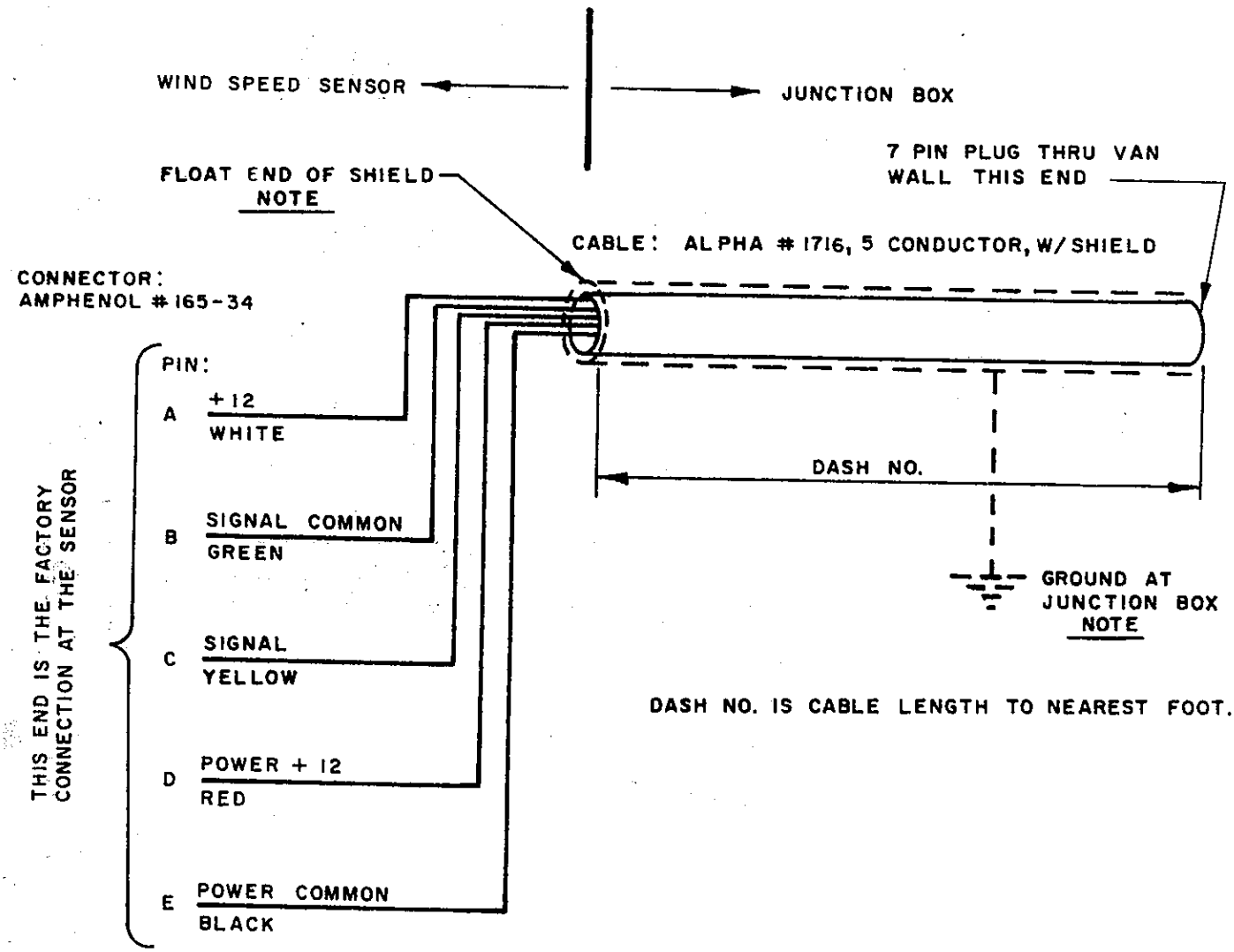


METEORLOGICAL MAST

Figure 72

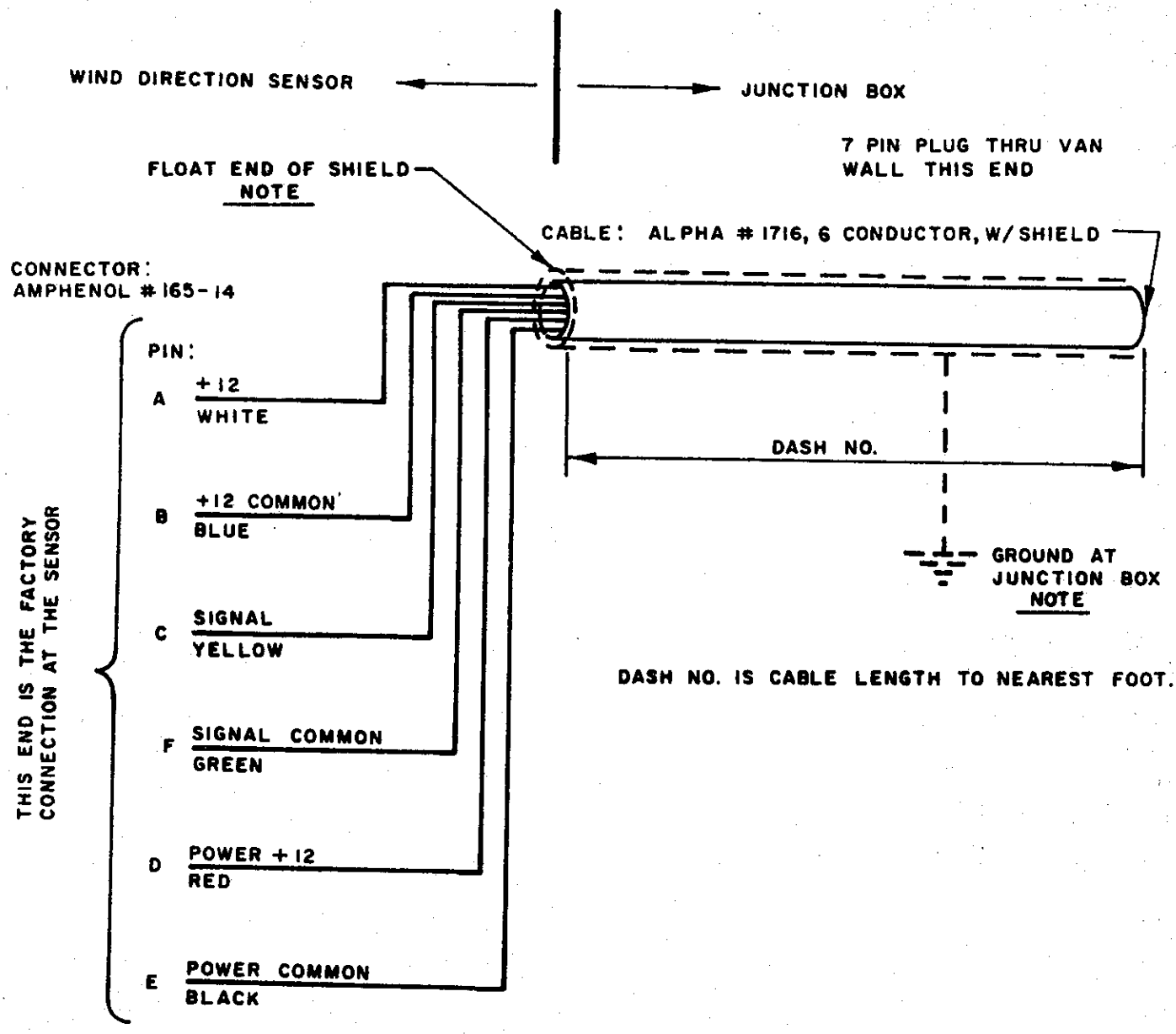


METEOROLOGICAL SENSOR CABLES
CONNECTION TO TRANSLATOR
Figure 73



WIND SPEED CABLE, SENSOR TO TOWER LEVEL JUNCTION BOX

Figure 74



WIND DIRECTION CABLE
SENSOR TO TOWER LEVEL J-BOX

Figure 75

Equipment Mounts for Shock and Vibration - Protection

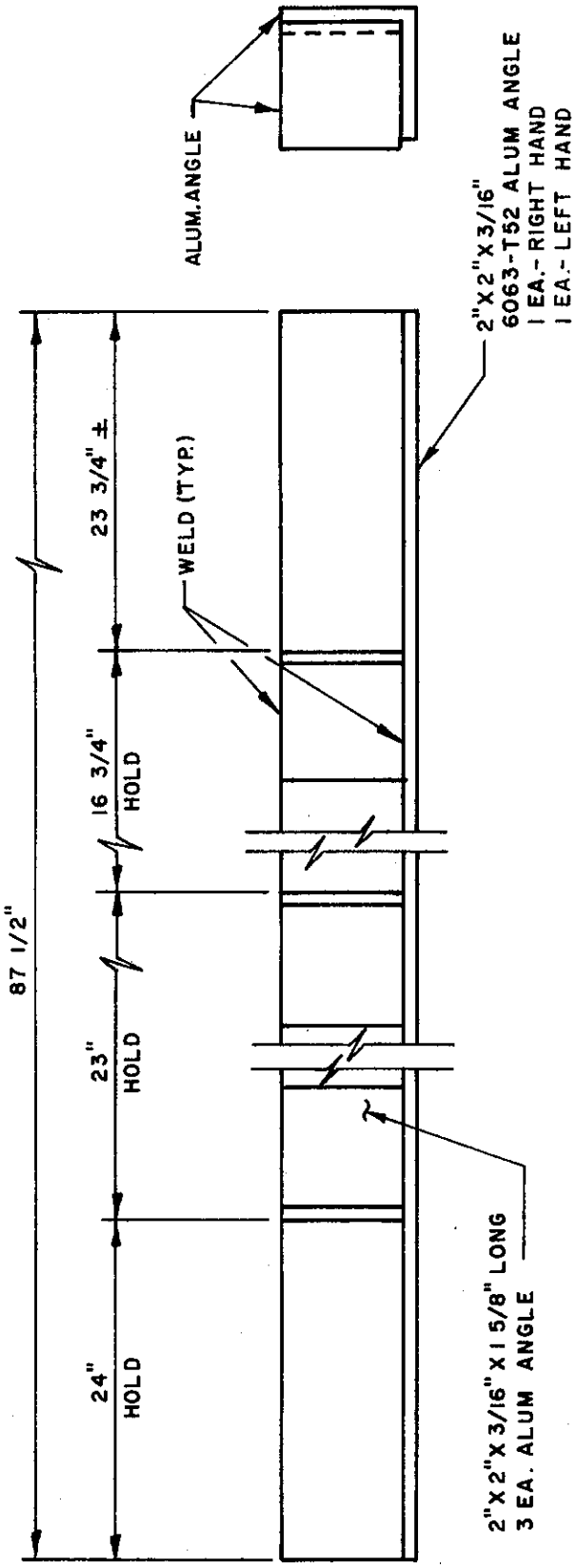
The electronic equipment in this van is sensitive to vibration. To preclude damage to components, broken connections, etc. and signal interference due to vibration transmitted to the detectors, shock mounts and vibration isolators are used where possible. Manufacturer's recommendations are used on all mount selections and they seem to be on the heavy side.

Mounts for Budd instrument racks
70" rack bottom - 4 each C-4100 T-10 Top 2 each C-2090-T6
61" " " 4 each C-4100 T-10 Top 2 each C-2090-T6

CO Analyzer Mounts

3 each C-1050-T4 Barry, for the analyzer section of the Beckman 315BL. 2 for bottom support, 1 at the top.
Air Compressor - remove tank and mount separately
Air Compressor - 4 each rubber mounts 5/16" NC thread. (Supports air compressor.)
Main Vacuum pump - 4 each rubber mounts 5/16" NC thread. (Supports vacuum pump.)
Location - there is room to mount these pumps forward of the rear wheel under the van. A power supply box is mounted for pump installation in this area. All electric power must be in a conduit with a mechanical ground wire.

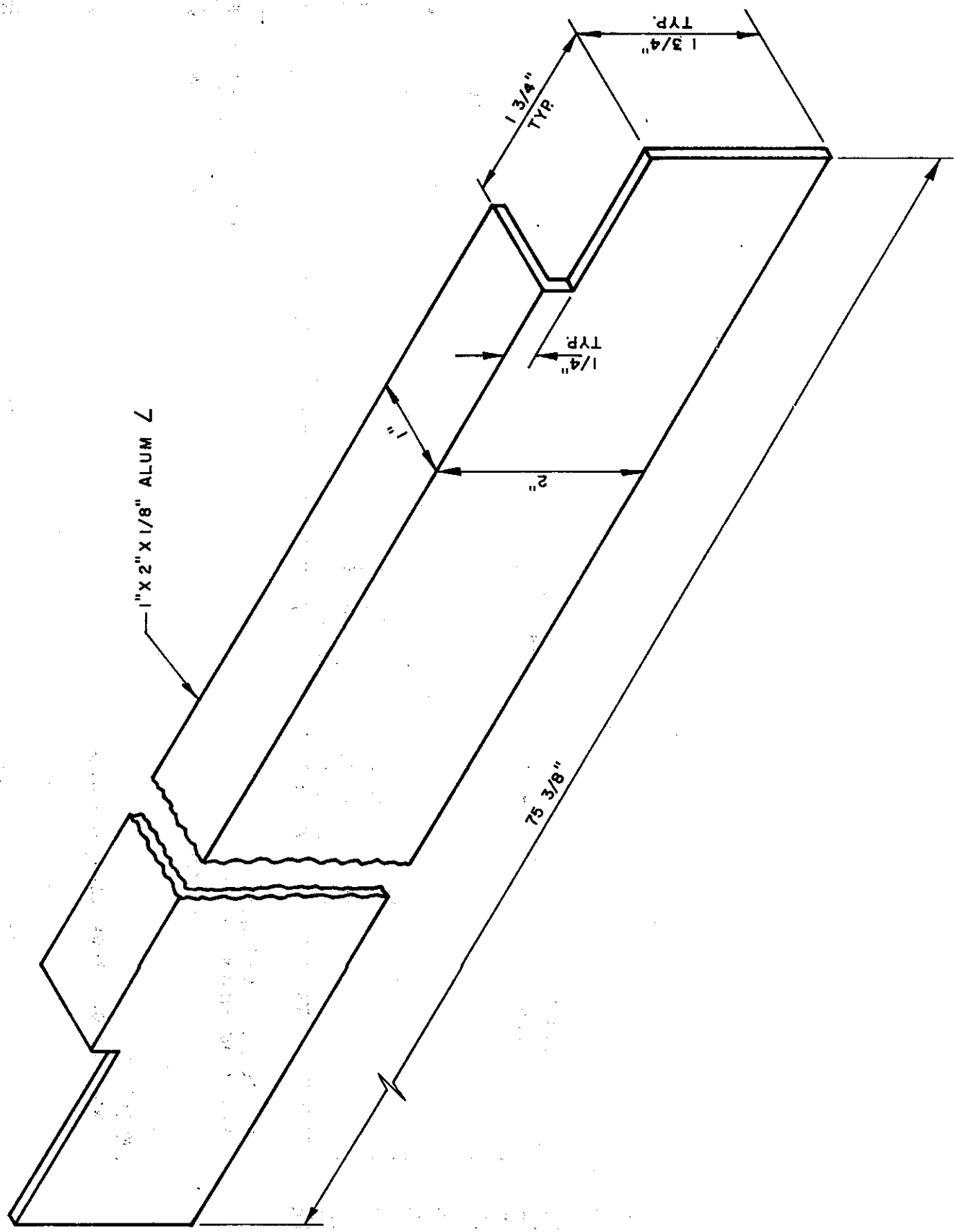
CO analyzer pump - MB21
Vibration mount
Model 315BL Beckman with MB21 pump optional. Use Metal Bellows Corporation Shockmount Model #MB21/41.
Model 865 Beckman with MB21 pump. Vibration could possibly effect this instrument. Use Metal Bellows Corporation Shockmount Model #MB21/41 or some similar type of vibration protection if the pump is mounted with the instrument.



NOTE:
WORK LAYOUT FROM LEFT END ONLY.

MINI VANS PANEL FRAME

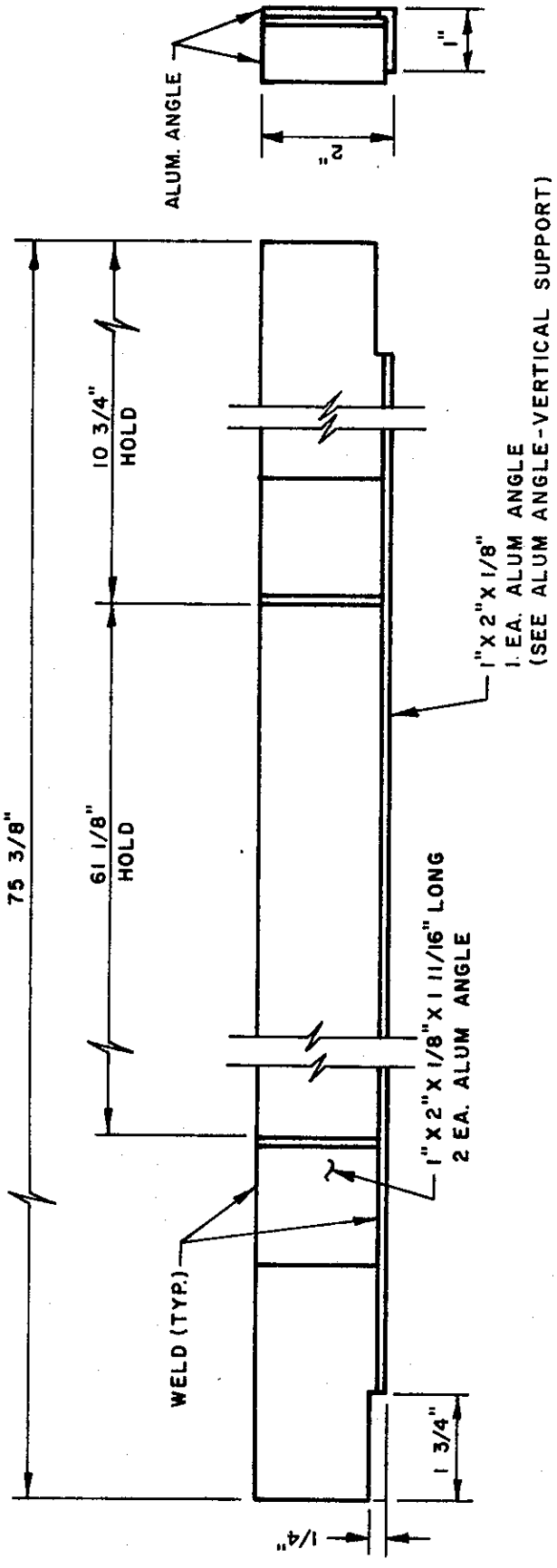
Figure 76



ALUM ANGLE - VERTICAL SUPPORT

3 EA. REQ'D. (INCLUDES 2 EA. FOR R.H. & L.H. DOOR FRAMES)

Figure 77

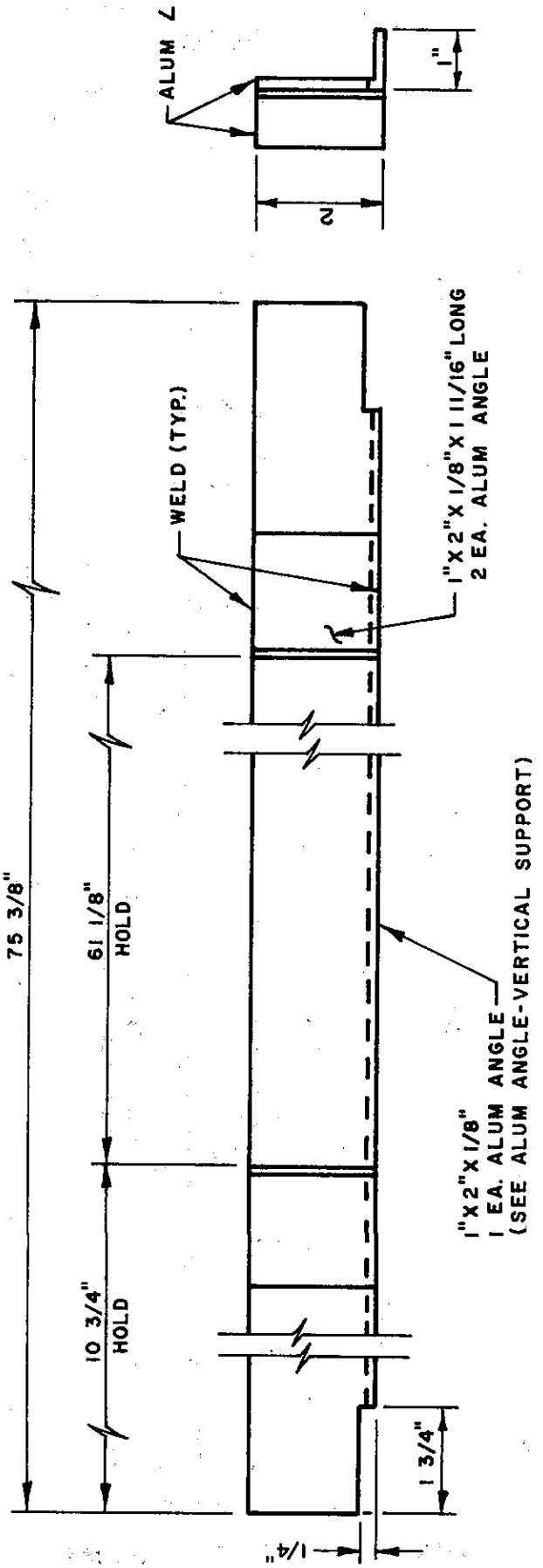


NOTE:
WORK LAYOUT FROM RIGHT END ONLY.

MINI VANS DOOR FRAME

(LEFT HAND FRAME)

Figure 78

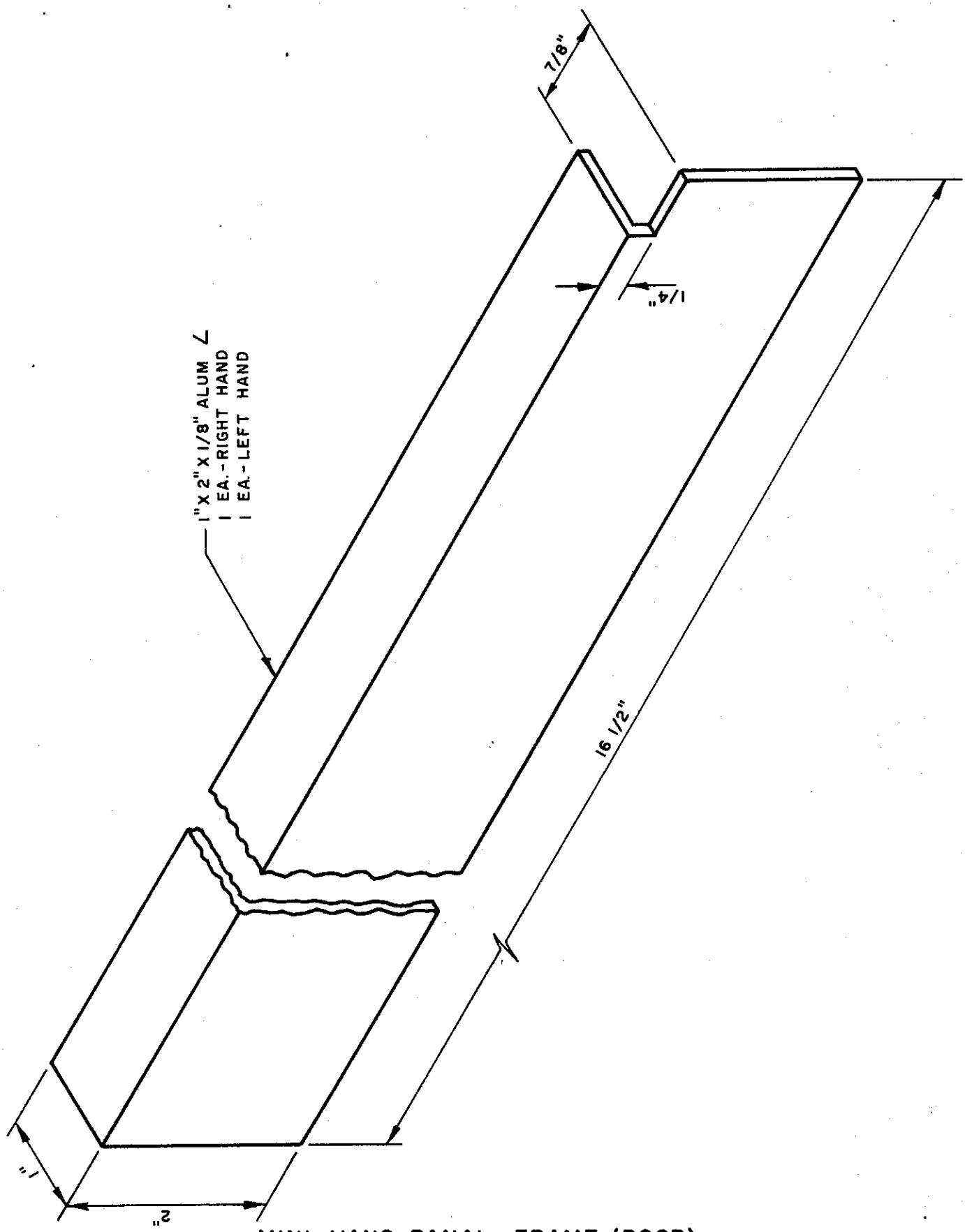


NOTE:
WORK LAYOUT FROM LEFT END ONLY.

MINI VANS DOOR FRAME

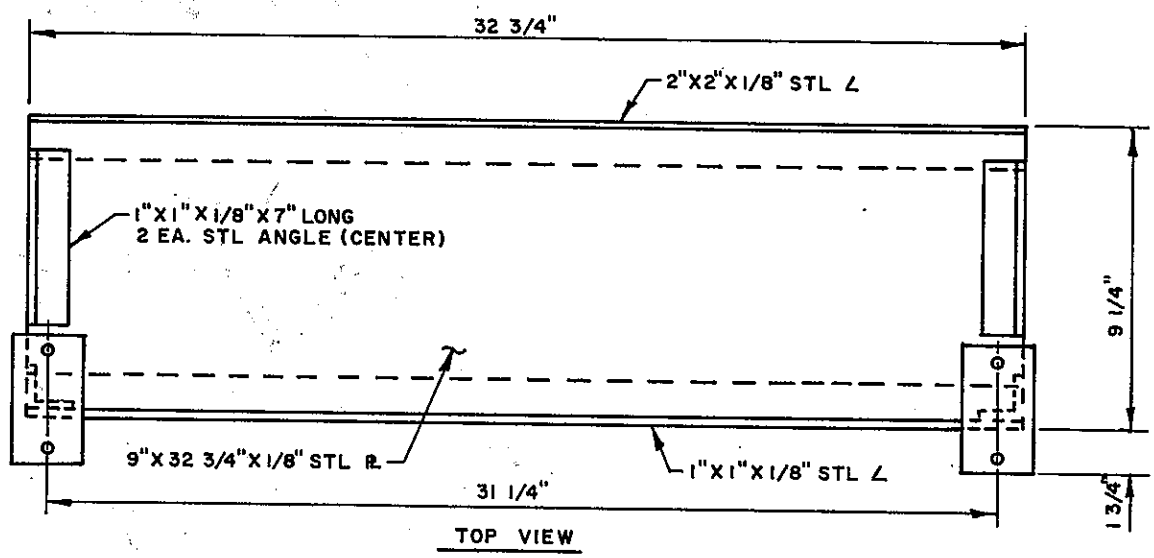
(RIGHT HAND FRAME)

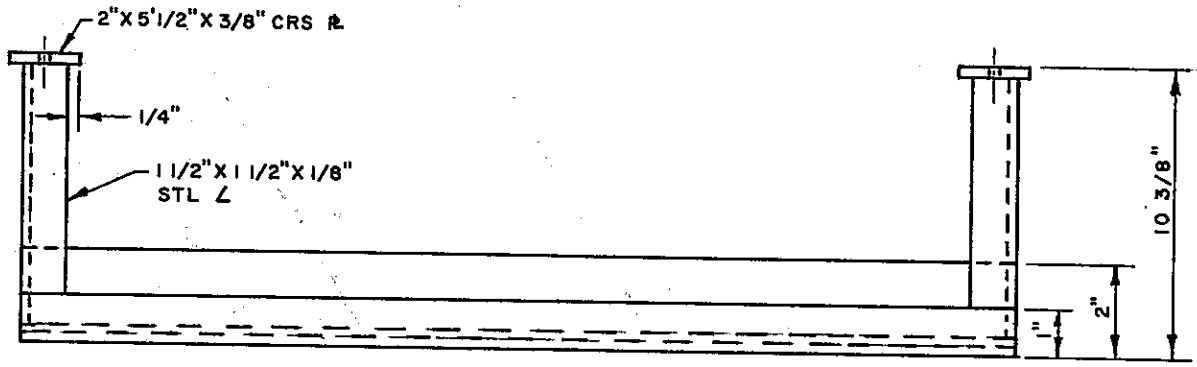
Figure 79



MINI VANS PANAL FRAME (DOOR)

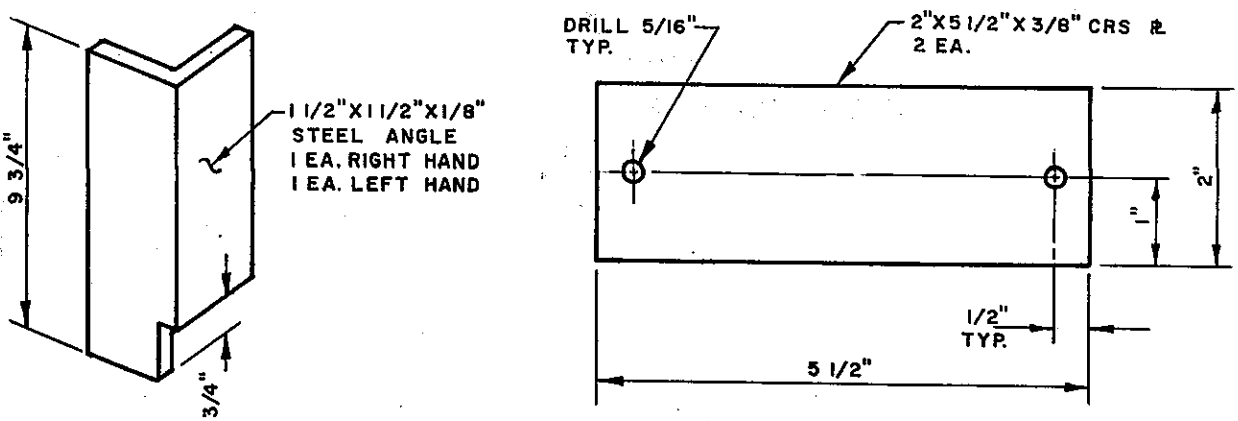
Figure 80





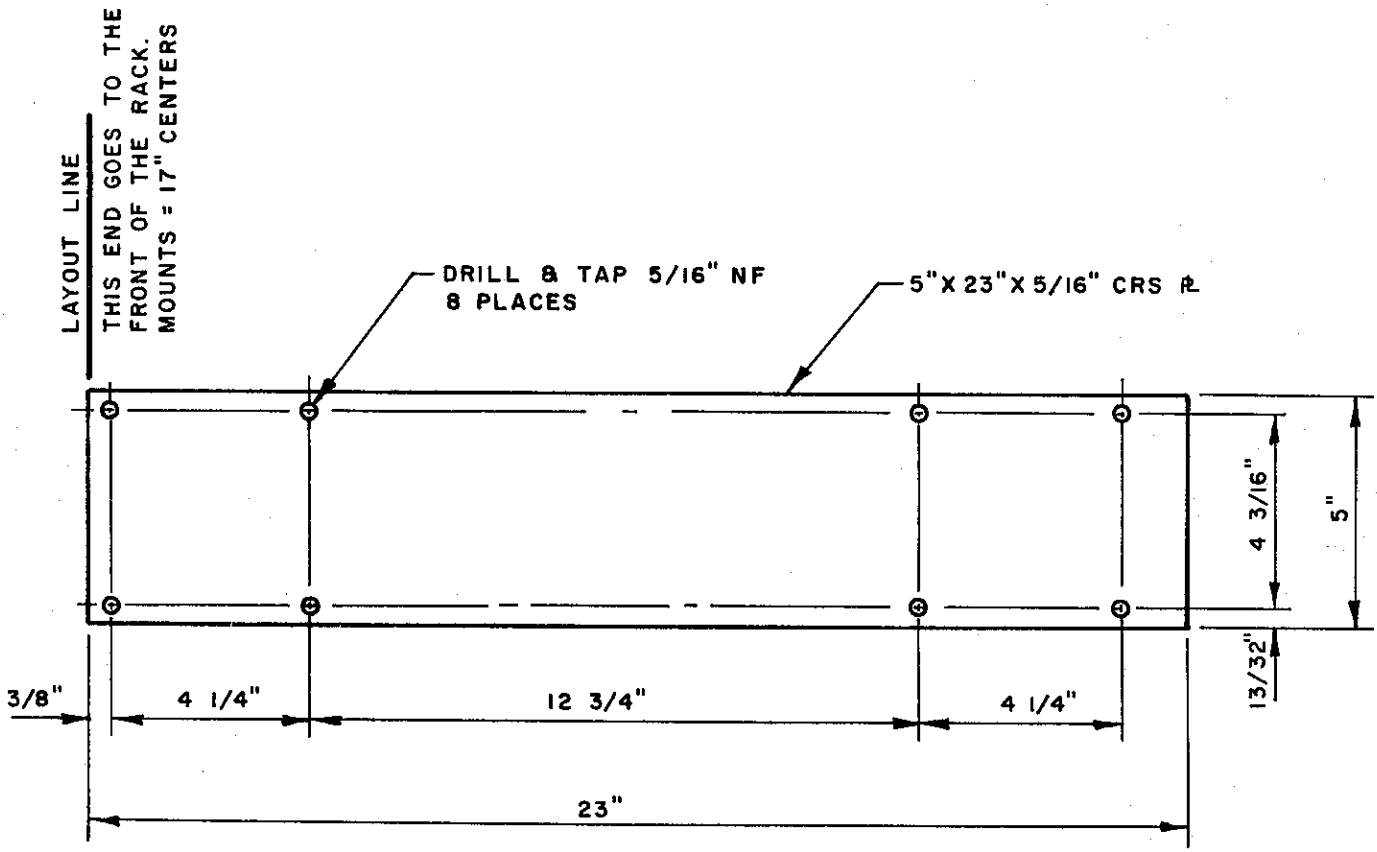
NOTE:
WELD ALL CONNECTING PARTS

ELEVATION VIEW



PUMP MOUNTING
(AIR COMP-MAIN VAC)

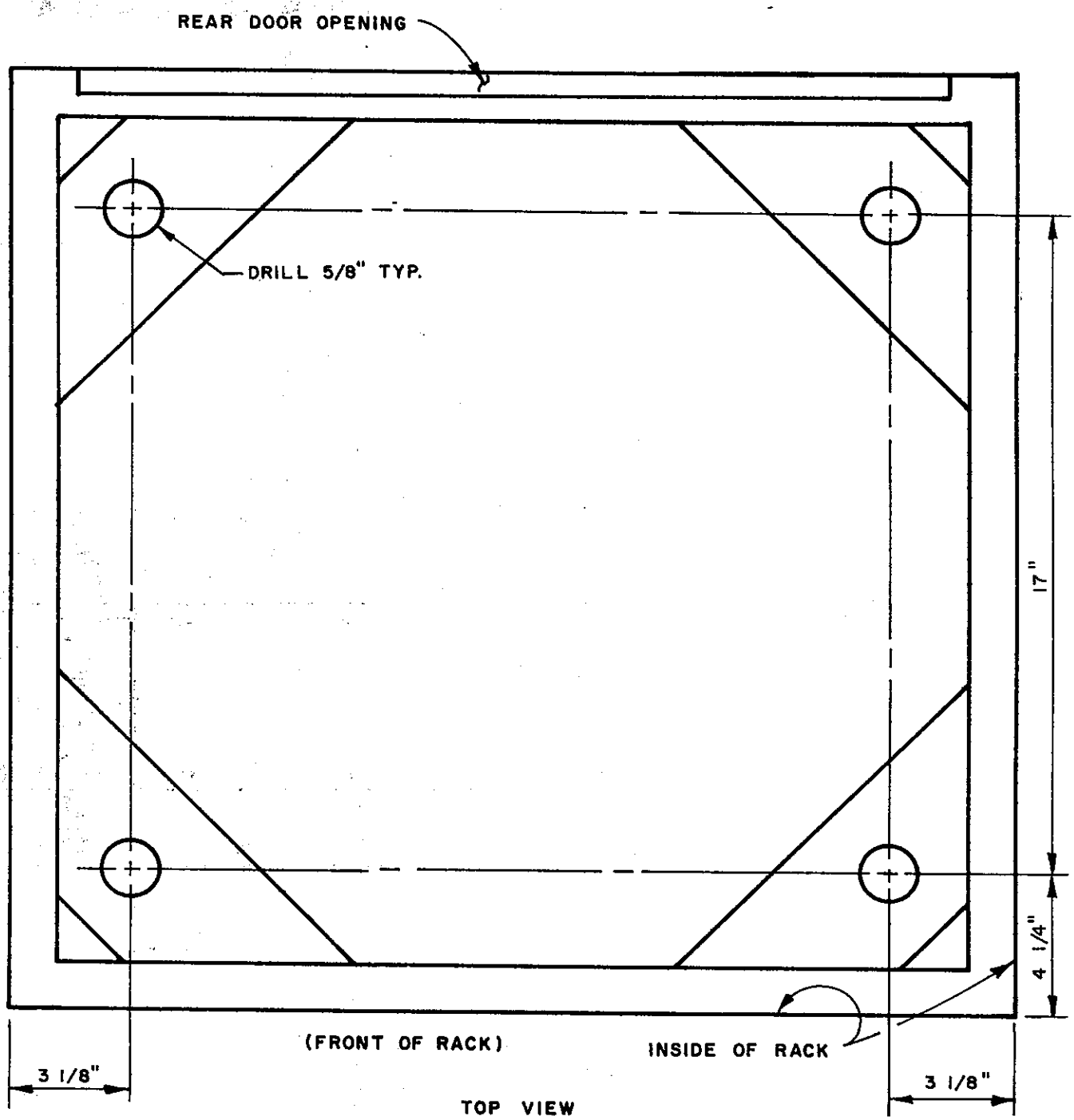
Figure 81



SHOCK MOUNT BASES FOR BUDD RACKS

2 EA. REQD. PER RACK

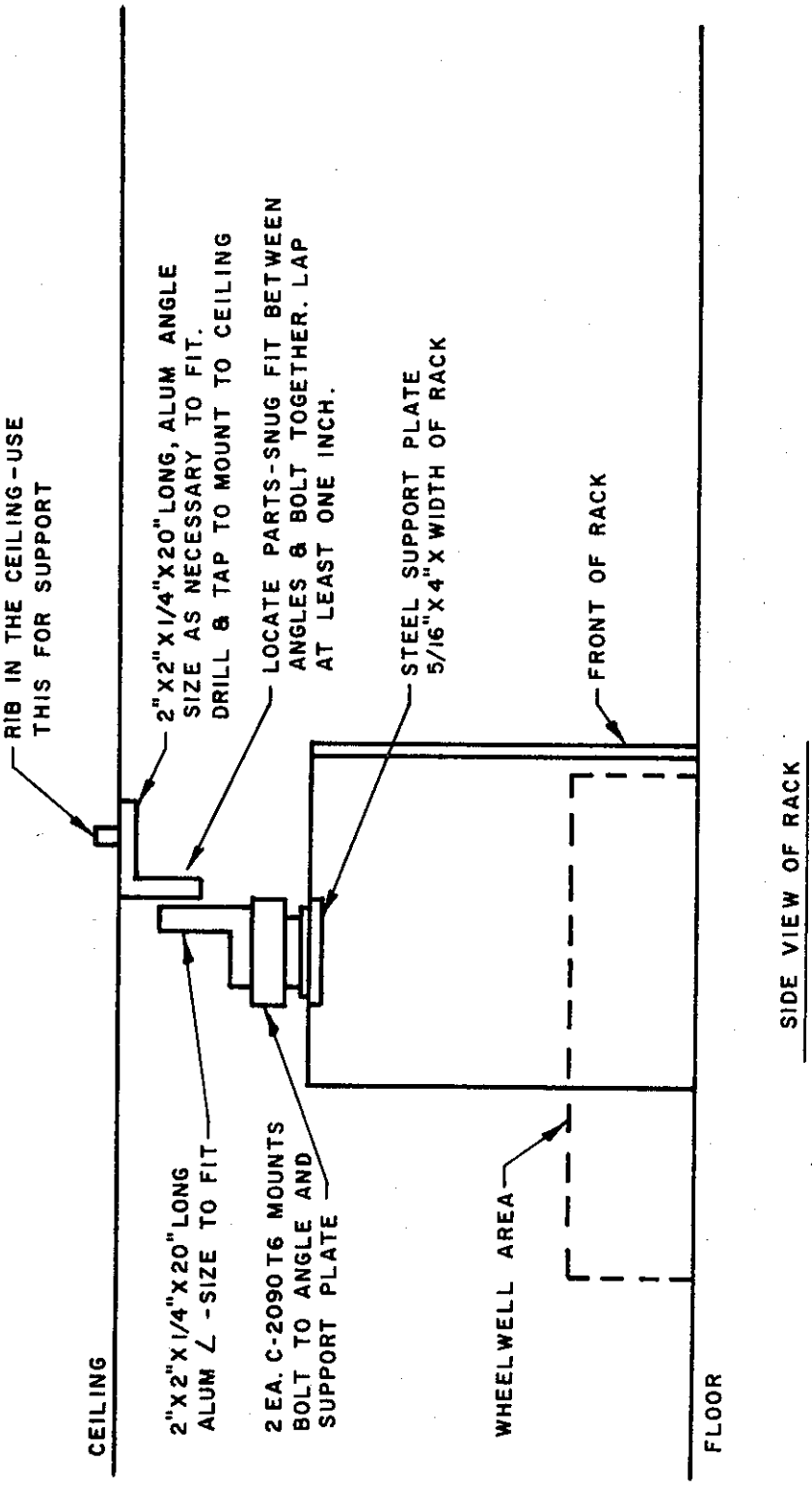
Figure 82



4 EA. SPACER REQ'D – 11/16" I.D., 1 1/2" O.D. X 11/16" ± THICK
4 EA. BOLT HEX HEAD WITH LOCKWASHER 5/8" NC X 1 3/4" LONG

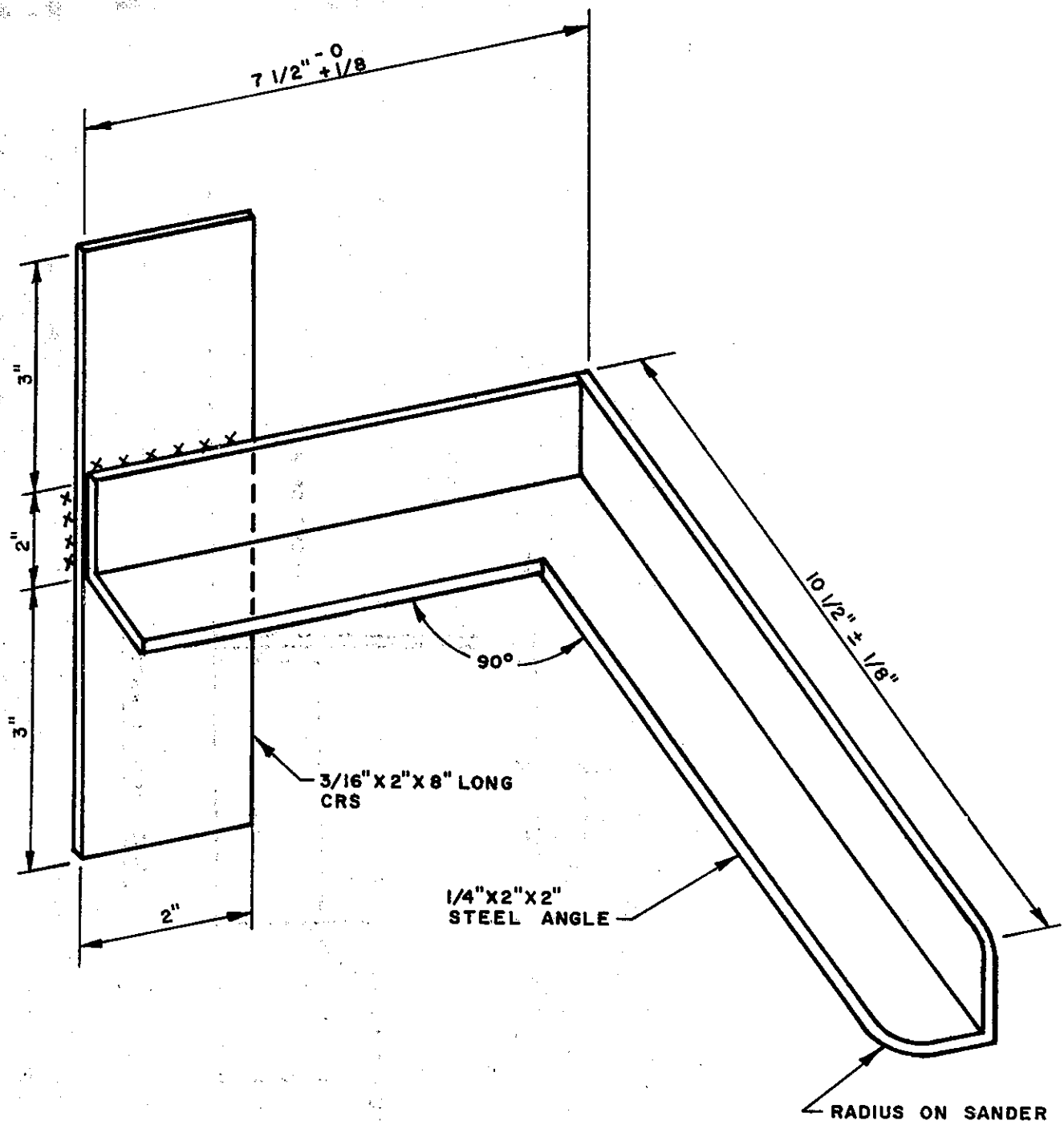
INSTRUMENT RACK–LAYOUT FOR SHOCK MOUNTS

Figure 83



RACK- TOP SHOCK MOUNTS

Figure 84



TOP MOUNT BRACKET CO ANALYZER SHOCK MOUNT

Figure 85

Recommended - Use shock mounts on the CO and NO_x pumps if they are mounted in or on the instrument rack. Optional location is to mount these pumps on the wheel well behind the instrument rack.

TECO NO_x Analyzer pumps
MB41 pump - no mount required unless it is mounted in the rack.
Option - Metal Bellows Corporation - Shockmount Model #MB21/41.

MB155 pump - do not use the Metal Bellows Corporation Shockmount for this pump as it has not been satisfactory. Instead use 4 each rubber mounts, 1/4" 20 thread, to support this pump. Fabricate a plate to mount the pump on, using the 4 rubber mounts.

Reference

Barry Controls
2323 Valley Street
Burbank, CA 91505

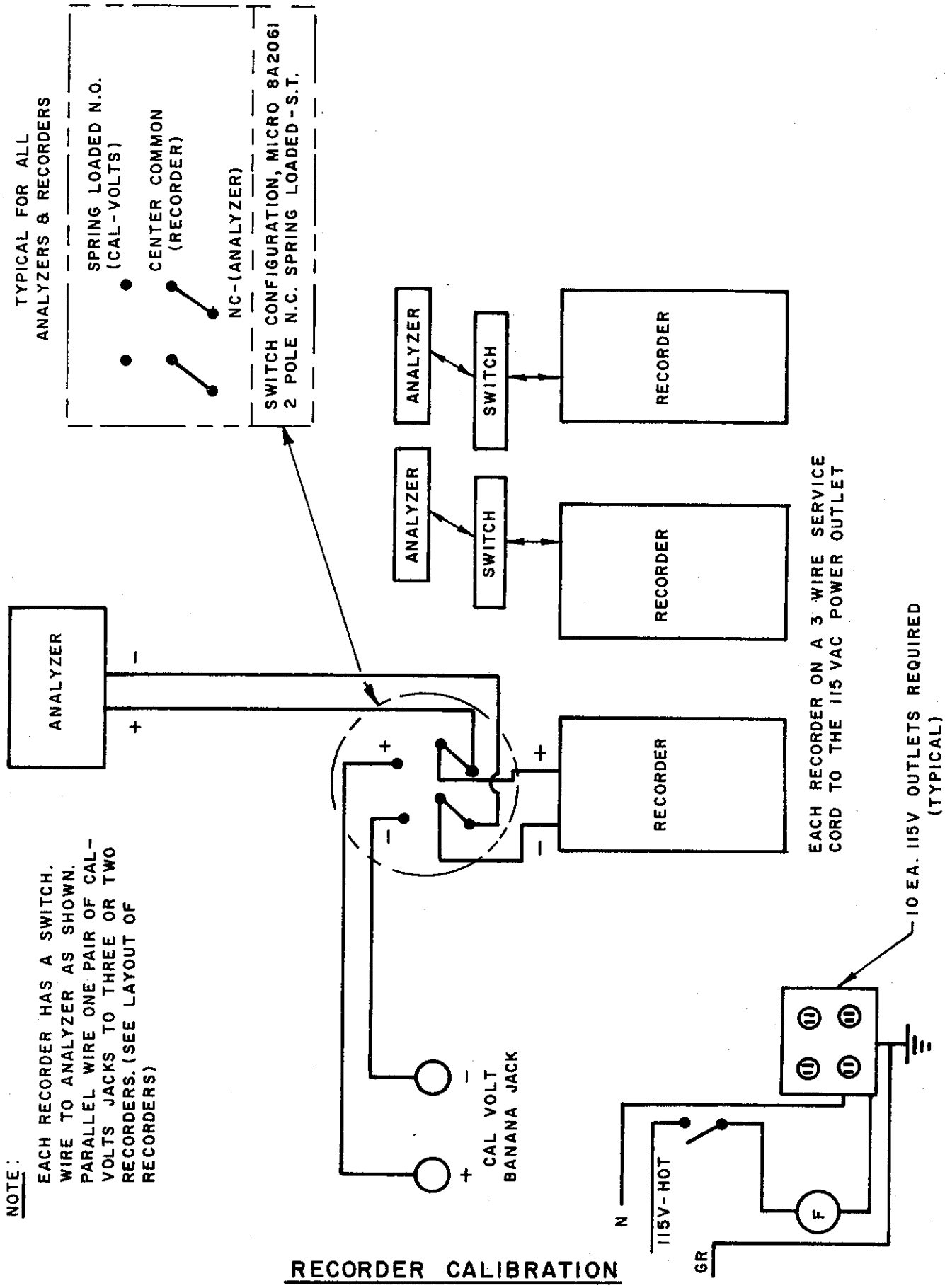
Metal Bellows Corporation
20977 Knapp Street
Chattsworth (LA) CA, 91311
Shockmount for MB21 and 41 pumps
Order Shockmount Model #MB21/41 - Price about $25.00

Recorder Panel

The data recording used is a Z-fold type strip chart recorder with cartridge pen marking. They have been modified by Translab to include a zero potentiometer (pot) adjust on the left side above the pen drive and a span pot in a corresponding position on the right side. Zero, span and linearity checks should be done with a DC voltage standard before using and then periodically thereafter.

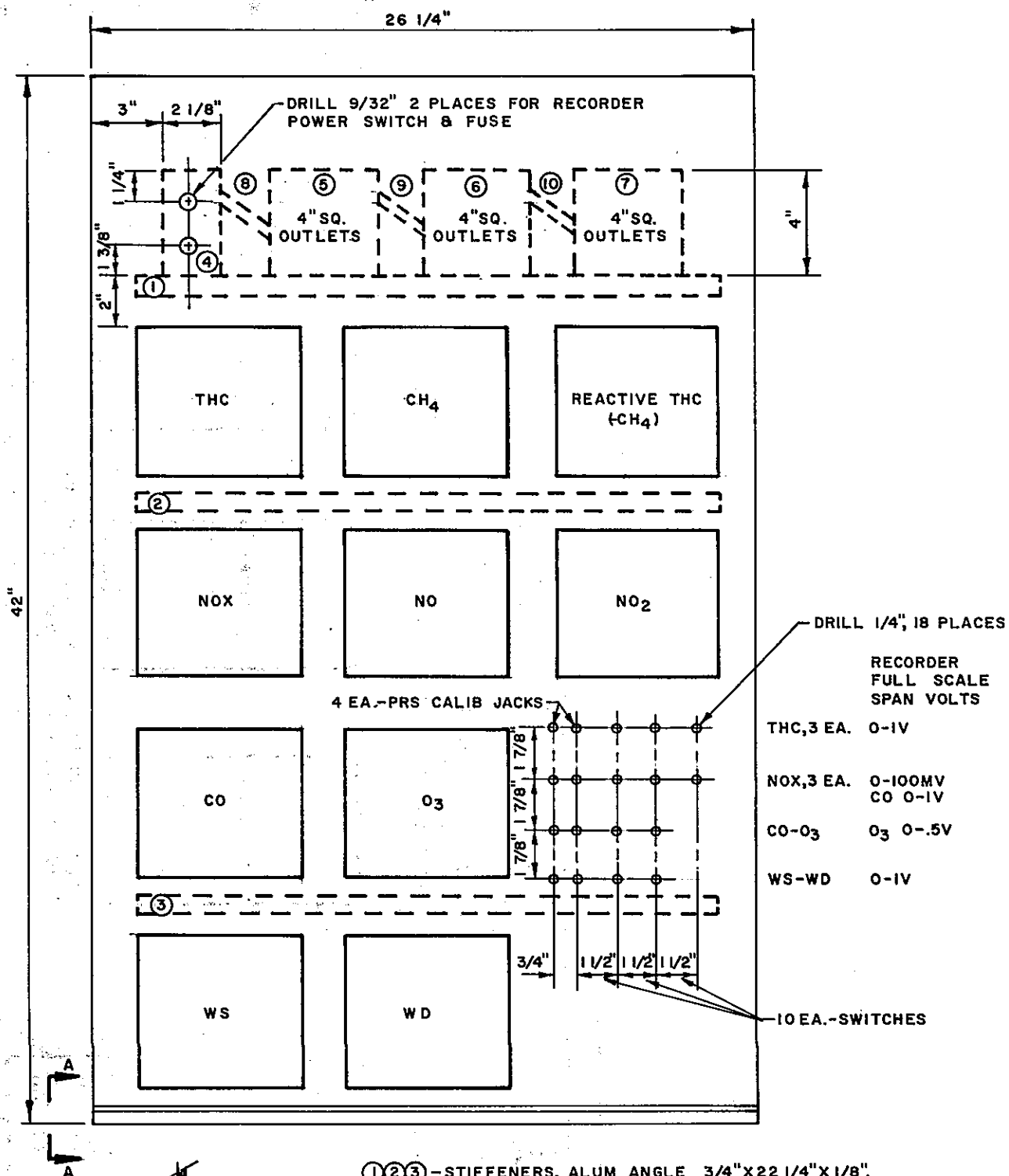
Parts List.

1 each switch for power-SPST
1 each fuseholder - panel mount
1 each 1/2" cord connector (electrical fitting)
3 each 1/2" off set nipple (electrical fitting)
1 each 1/2" handy box extension ring (electrical fitting)
3 each 1/2" - 4" square boxes (electrical fitting)
3 each 4" covers for 2 duplex outlets (electrical fitting)
6 each duplex outlets (electrical fitting)
11 each service cords 16 to 18 gage, 3 wire with moulded plug "U" ground type.
1 each of these for power to the switch and fuse, 10 each for the recorders.
1 each handy box blank cover (electrical fitting)
4 pair of calibration jacks
10 each switch #8A2061



RECORDER CALIBRATION

Figure 86

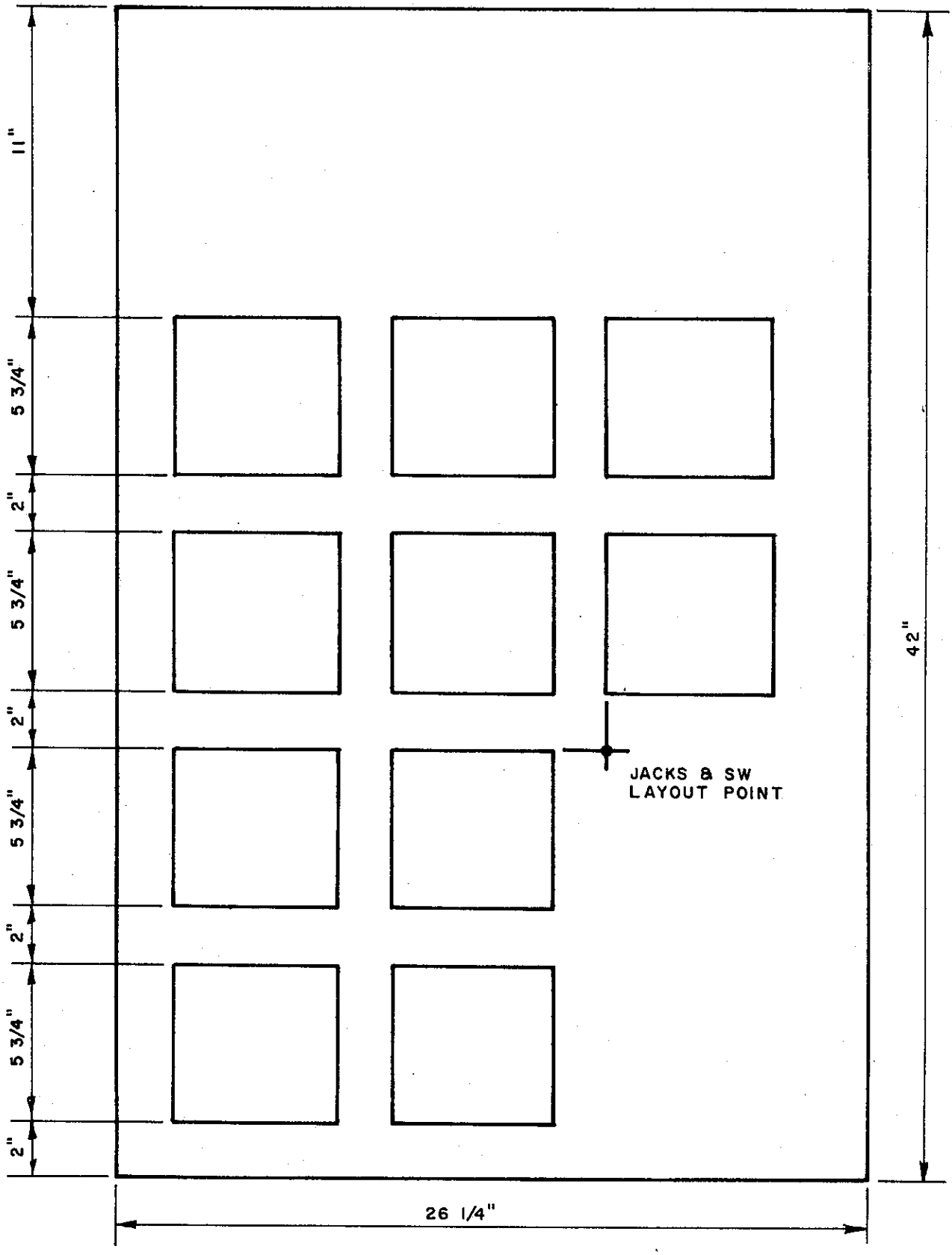


(1)(2)(3) - STIFFENERS, ALUM ANGLE 3/4"X22 1/4"X 1/8".
(4) - HANDY BOX (ELECTRIC) EXTENSION RING
(5)(6)(7) - 4" SQ. ELECTRIC BOX FOR OUTLETS
(8)(9)(10) - 1/2" CONDUIT-OFFSET NIPPLE
(ALL THE ABOVE PARTS MOUNT ON THE REAR OF THE PANEL)

RECORDER PANEL

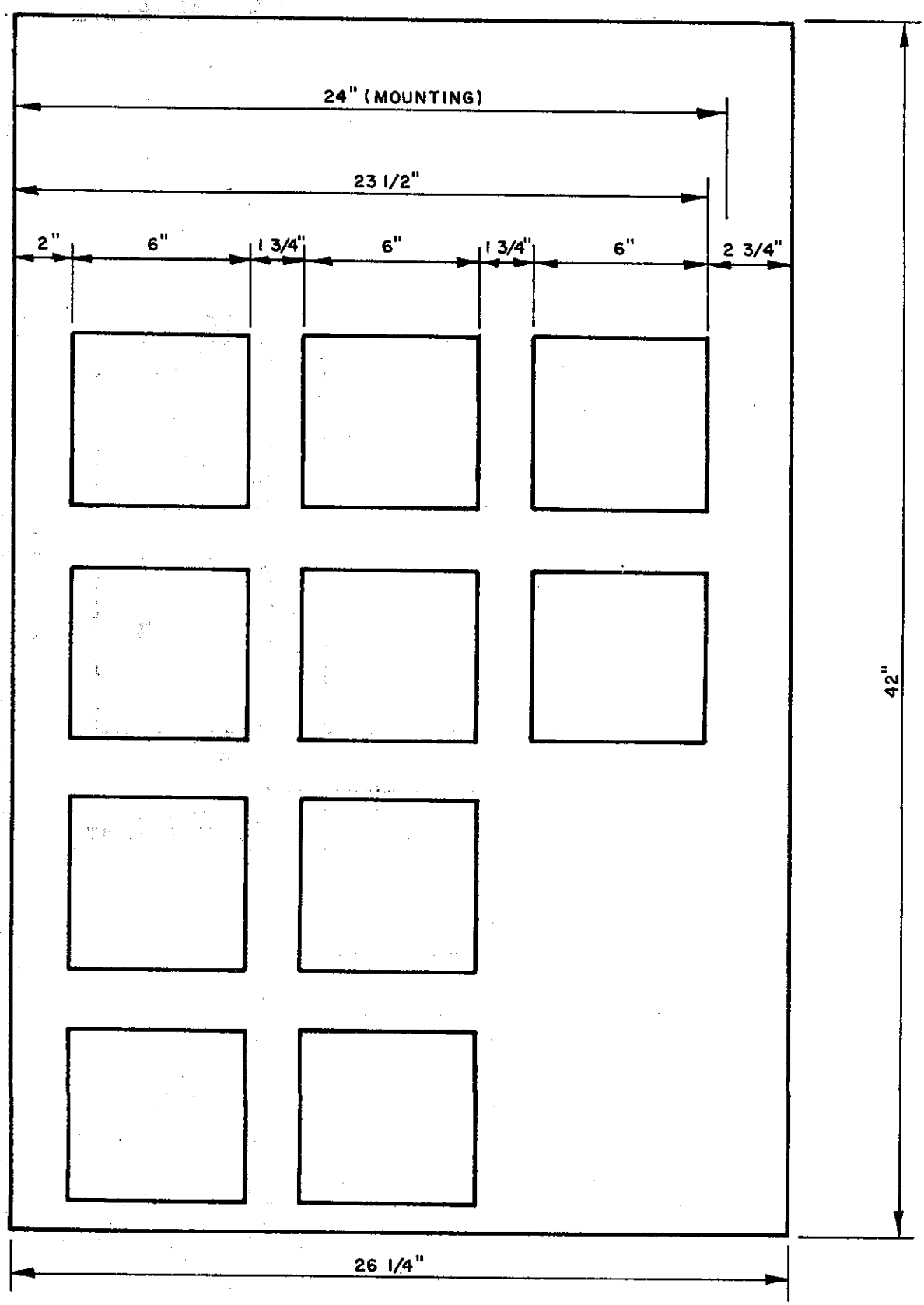
16 GA. BLACK SHEETSTEEL
1 EA. REQ'D.

Figure 87



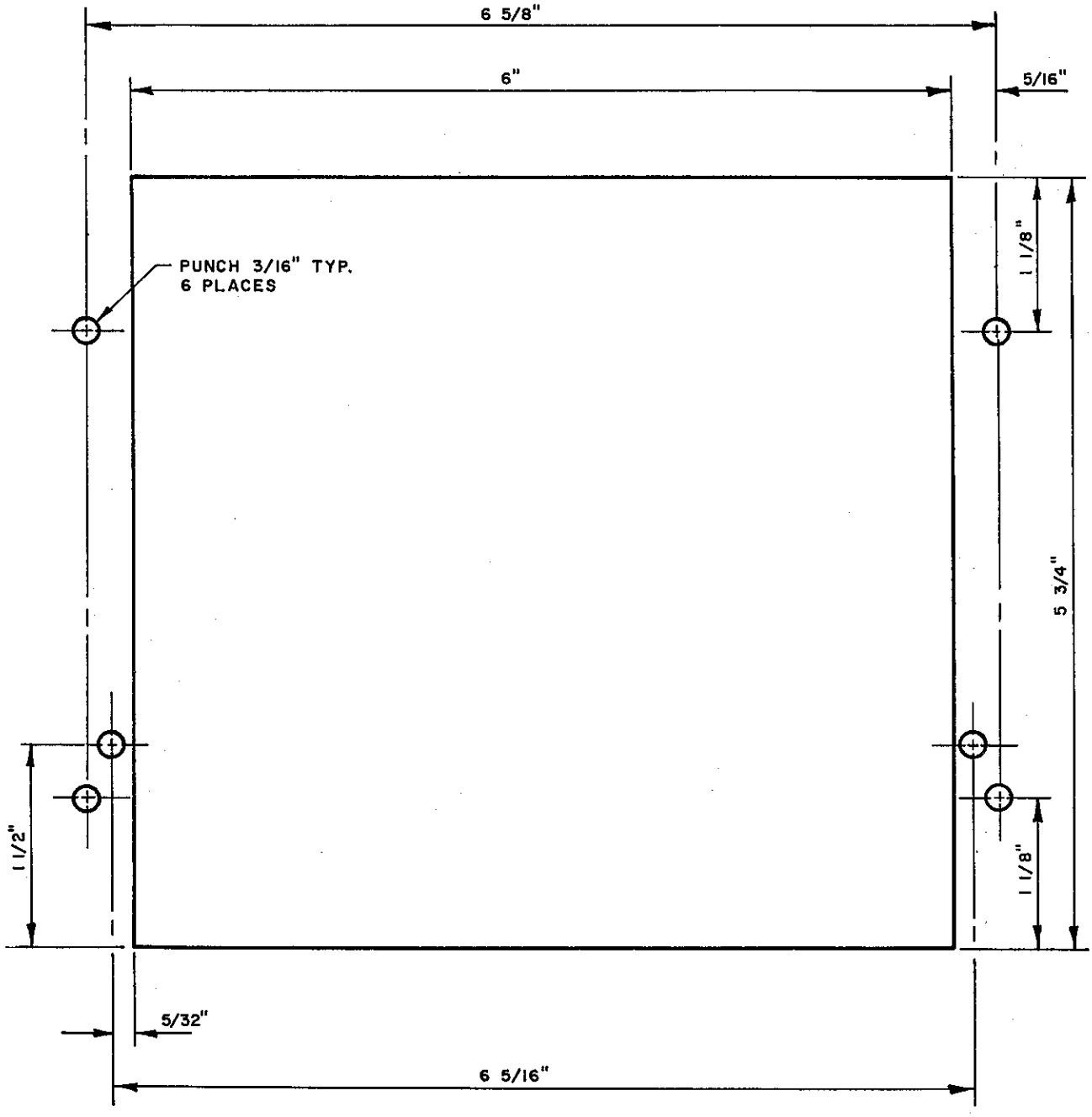
MINI VANS-RECORDER PANEL

Figure 88



RECORDER PANEL

Figure 89



TYPICAL LAYOUT OF HOLES FOR EACH RECORDER
6 EACH-HOLES PER RECORDER

Figure 90

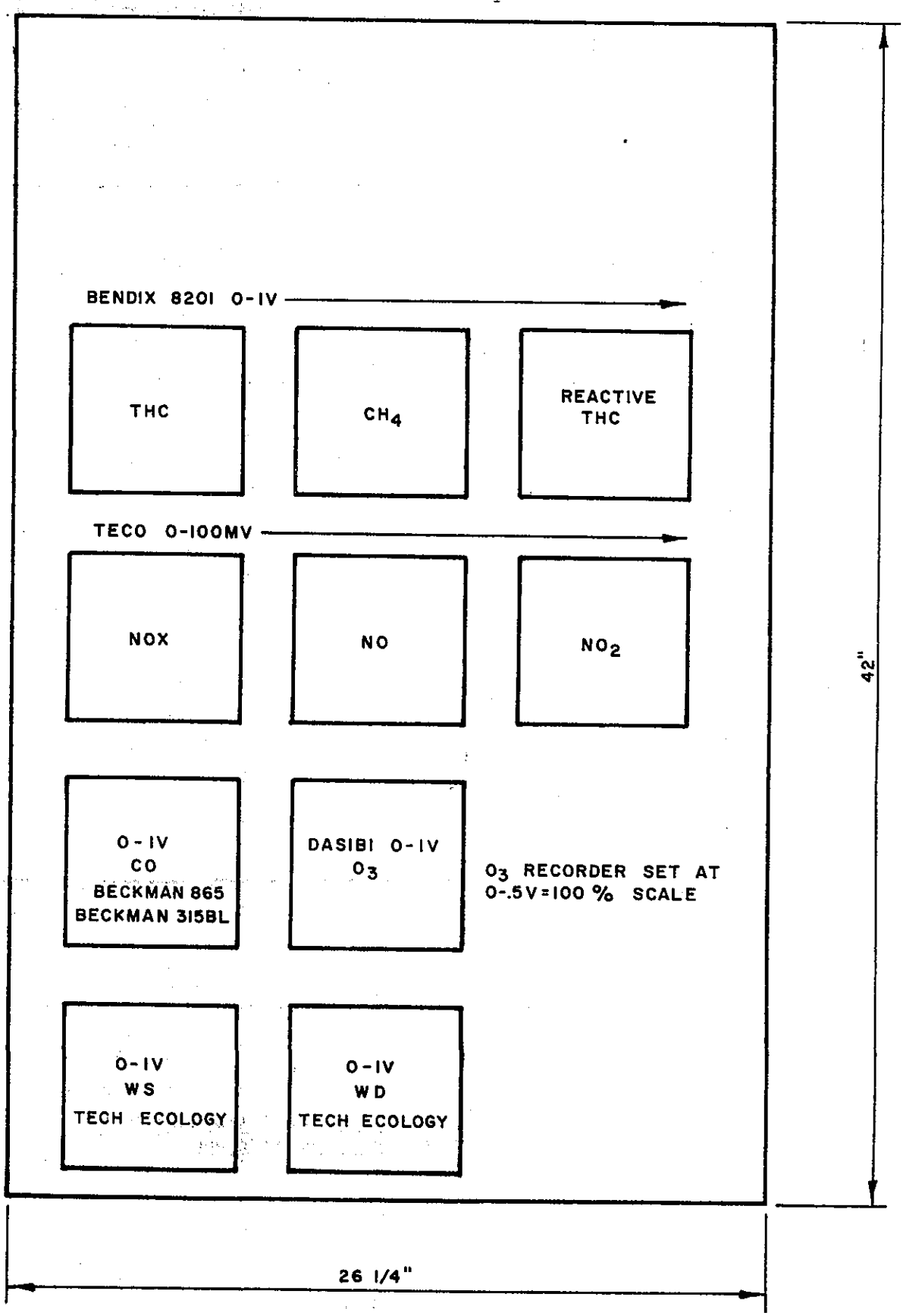
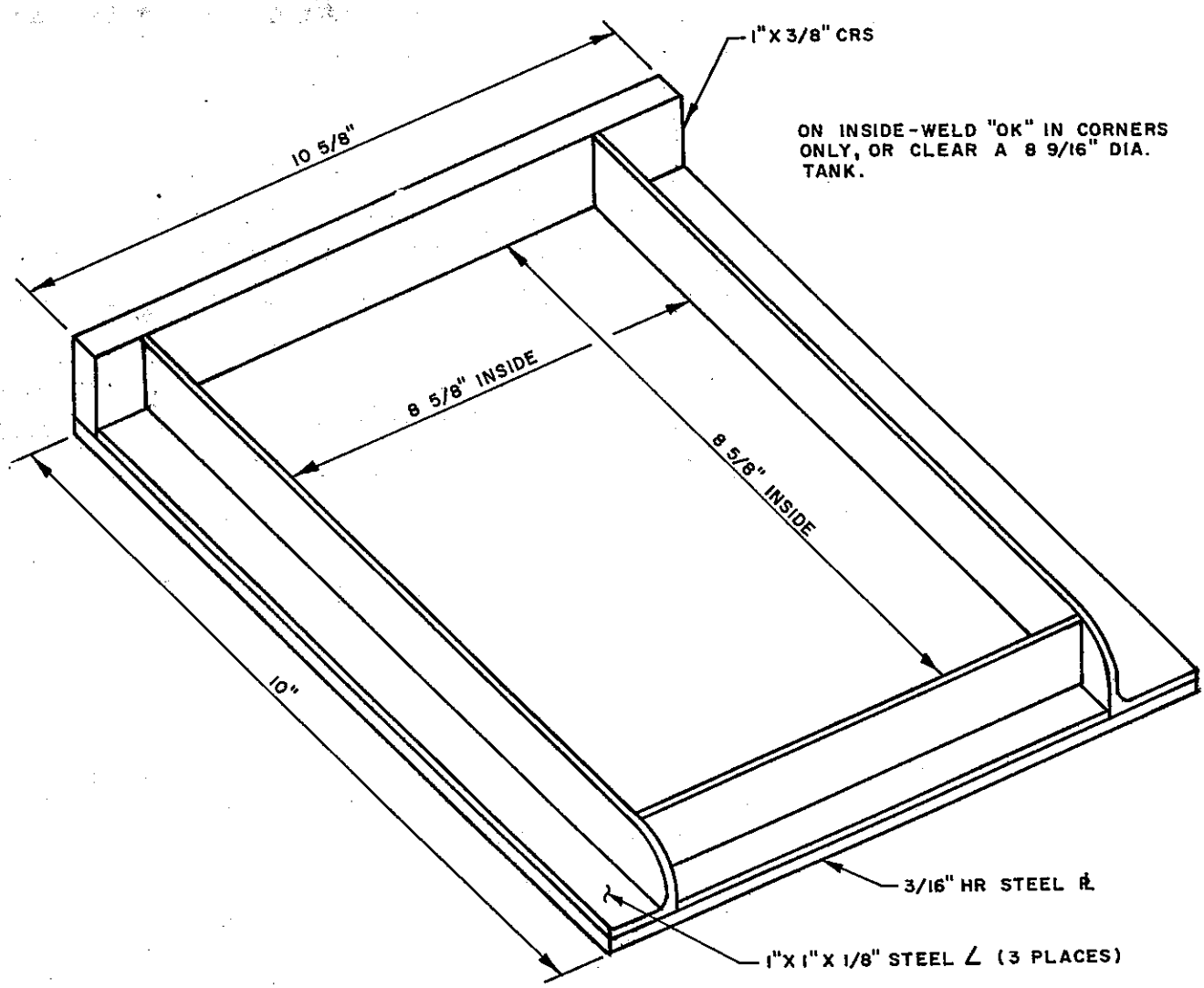


Figure 91

Calibration Gas Cylinders

Span cylinders are used for CO, THC, and NO_x analyzers. In addition, one cylinder of zero air is used for the 315BL CO analyzer. The THC span cylinder is mounted on the right wheel well behind the recorder panel and is plumbed to a needle control valve in the front of the support drawer. The CO span gas cylinder and zero air are plumbed to the CO flow control panel. The NO_x is plumbed to a divider system to provide excess flow to the demand of the analyzer and must be connected to the sample input port when calibrated. See drawings for mounting brackets necessary. Top brackets fit 80 size steel cylinders; adapters can be fabricated to hold smaller diameter aluminum cylinders as necessary.

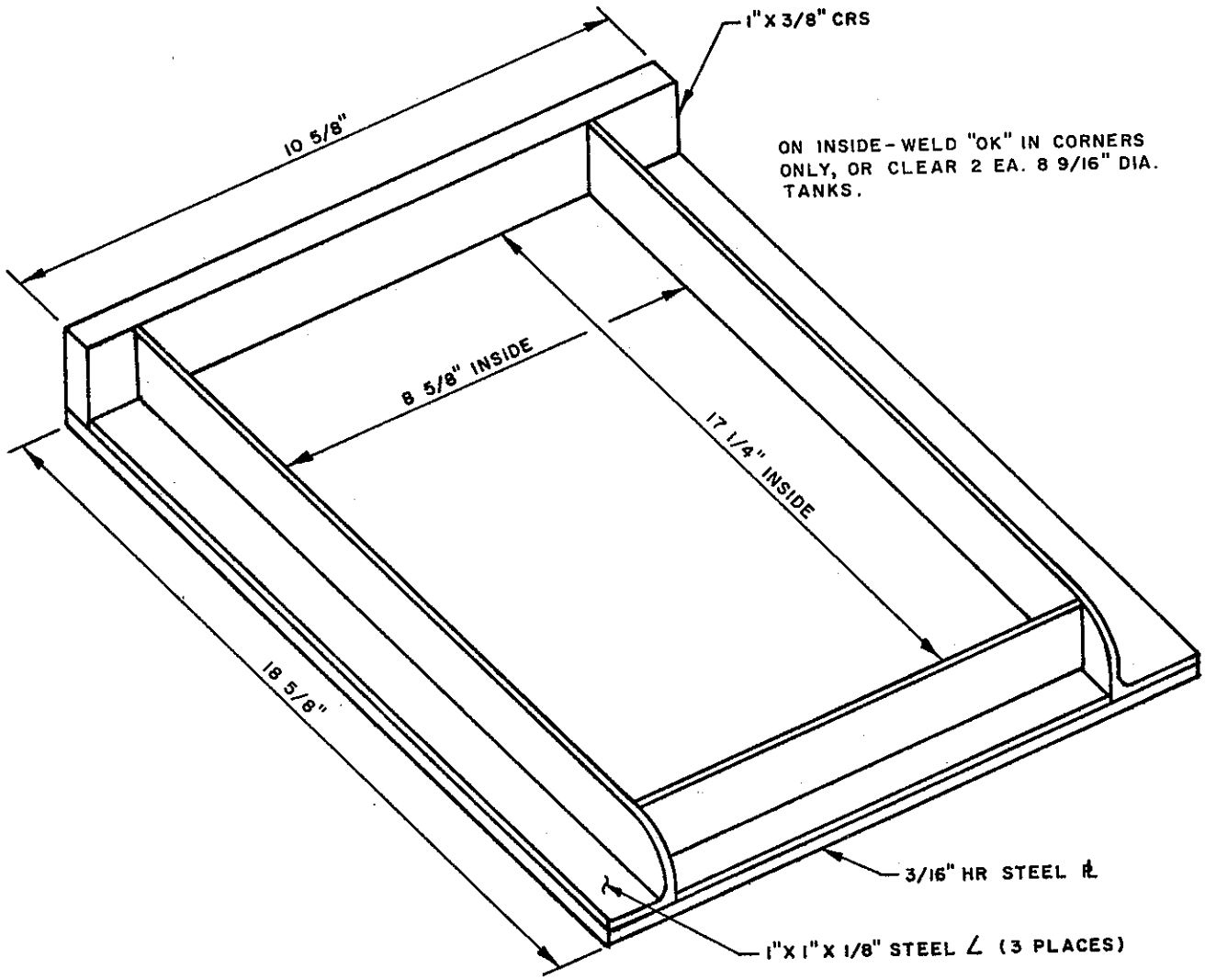


MATERIALS:

1 EA. 10"X 10 5/8"X 3/16" HR STEEL, SHEET
1 EA. 10 5/8" X 1" X 3/8" CRS, FLAT
1 EA. 1"X 1"X 1/8"X 8 5/8" LONG STEEL ANGLE
2 EA. 1"X 1"X 1/8"X 9 5/8" LONG STEEL ANGLE
RADIUS 1/2" ON ONE END, 1 RH, 1 LH

TANK BASE PLATE
(SINGLE MOUNTING)
WELDED

Figure 92

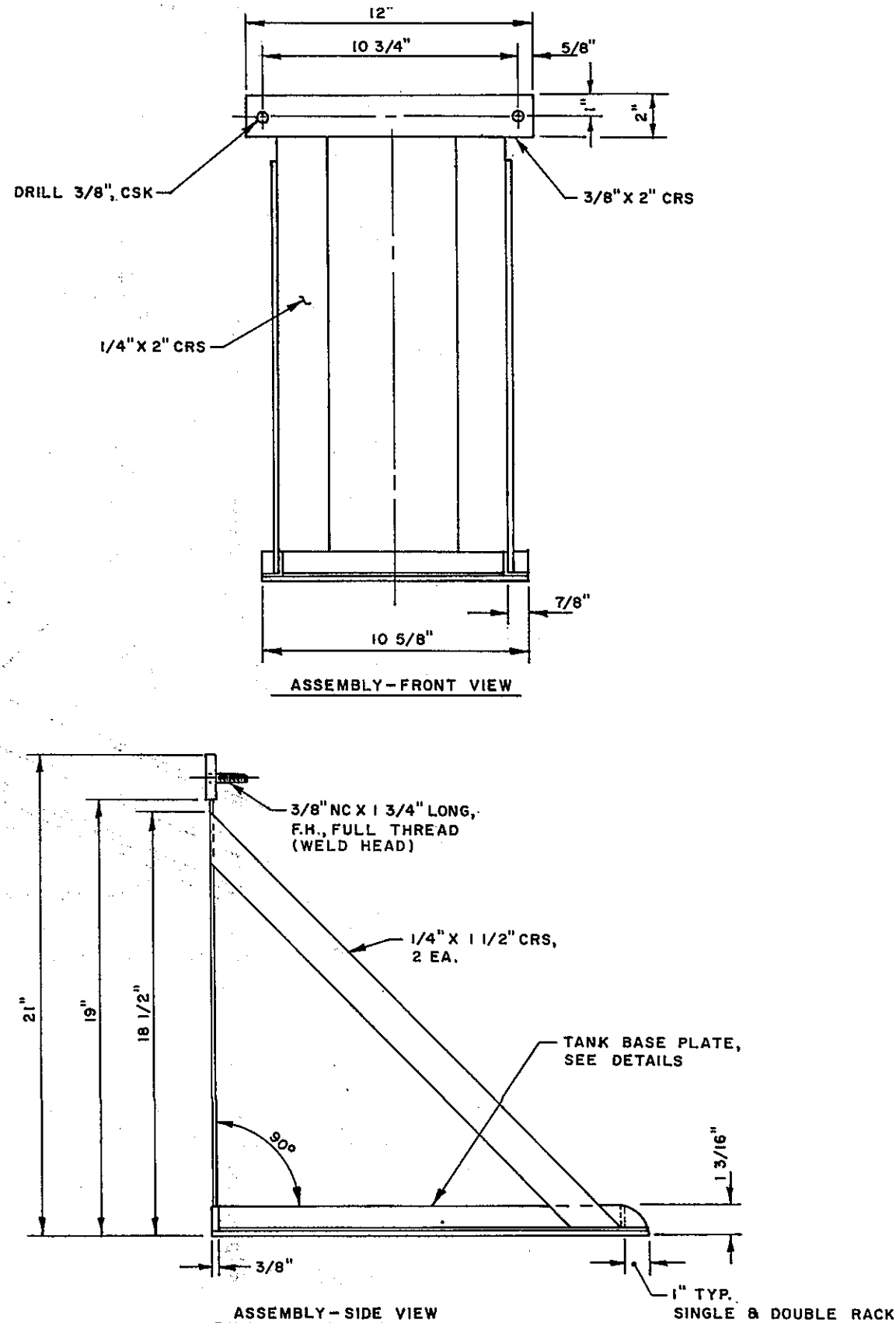


MATERIALS:

1 EA. 10 5/8"X 18 5/8"X 3/16" HR STEEL, SHEET
1 EA. 10 5/8"X 1"X 3/8" CRS, FLAT
1 EA. 1"X 1"X 1/8"X 8 5/8" LONG, STEEL ANGLE
2 EA. 1"X 1"X 1/8"X 8 1/4" LONG, STEEL ANGLE RADIUS 1/2" ON ONE END 15 RH, 15 LH

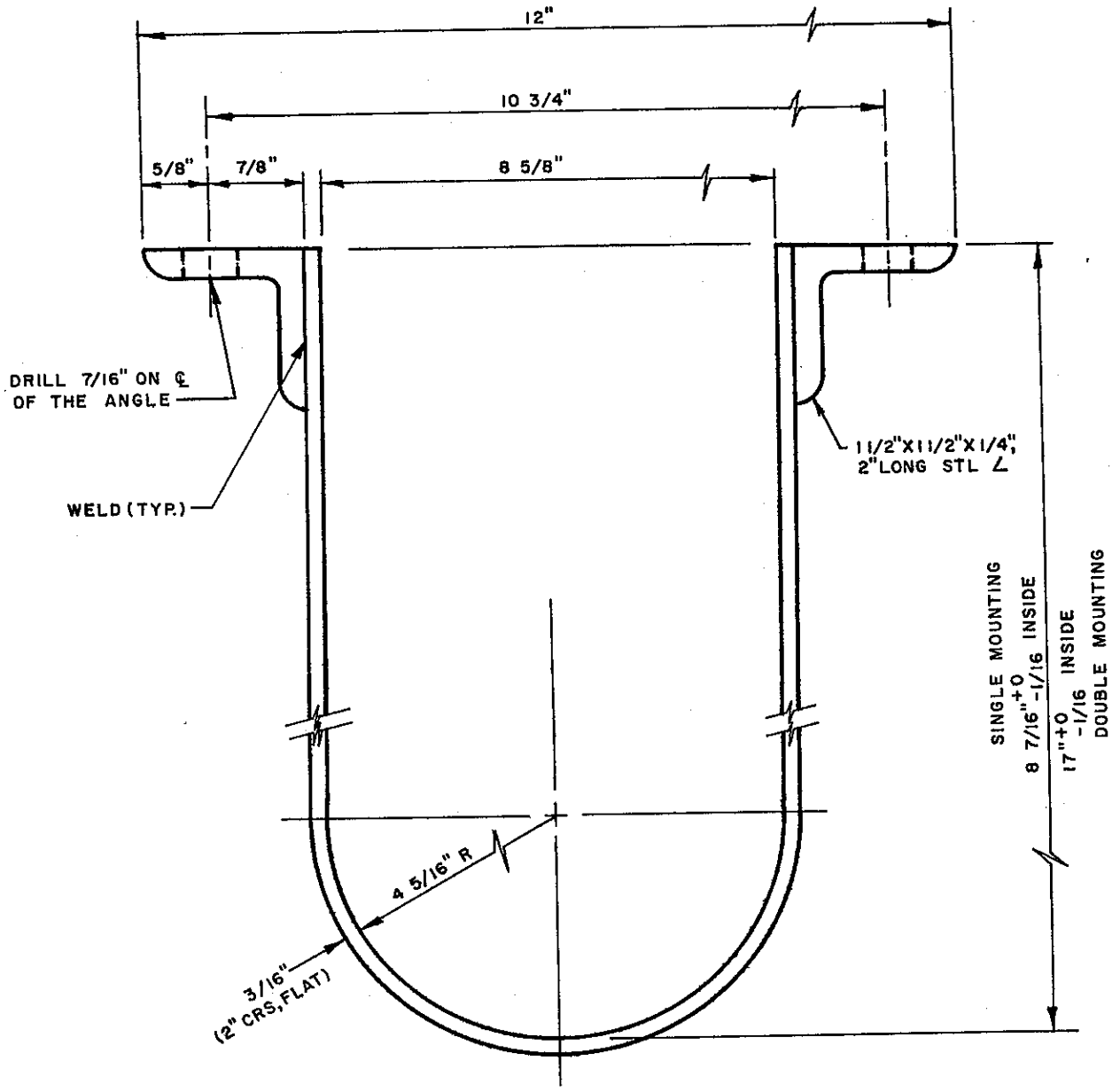
TANK BASE PLATE
(DOUBLE MOUNTING)
WELDED

Figure 93



CYLINDER MOUNTING RACK

Figure 94



CYLINDER MOUNTING CLAMPS

Figure 95